



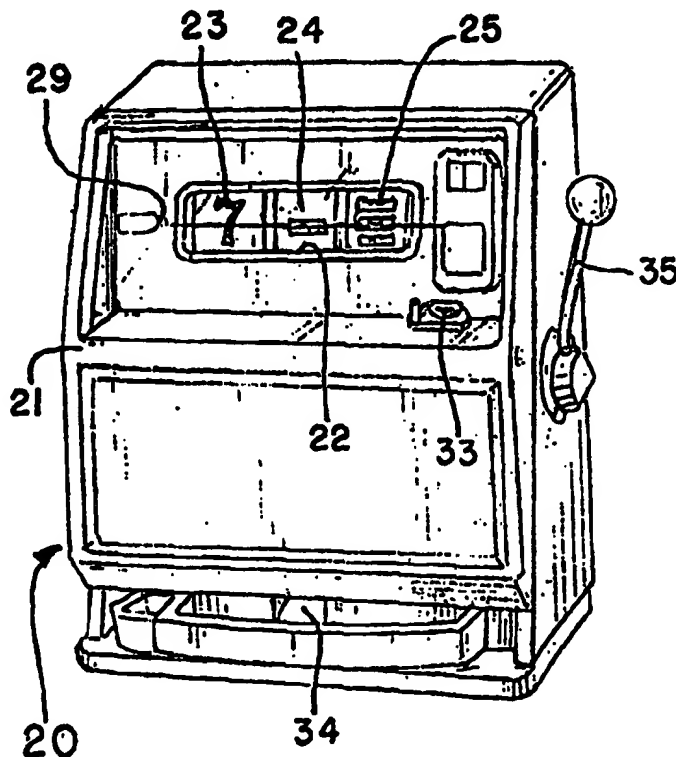
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(54) Title: REEL-TYPE SLOT MACHINE UTILIZING RANDOM NUMBER GENERATOR FOR SELECTING GAME SYMBOLS

## (57) Abstract

A reel-type slot machine (20) includes a micro processor driven game control circuit for randomly determining three game symbols (23-25) to be displayed as a result as a game result. Three reel assemblies (26-28) each include symbol-bearing reel driven by a stepper motor (40) for displaying one of the three symbols. A random number generator generates a random number within a pre-determined range of numbers for application to a lookup table wherein a game result consisting of three symbols is selected. Each different game result is identified with a particular subset of random numbers within the total range of random numbers. The size of the subset determines the probability for a game result to occur. After a game result is selected, the reels are driven by the stepper motor (40) to display the selected game symbols. The stepper motor may ramp up or ramp down for increased stepping accuracy.



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REEL TYPE SLOT MACHINE UTILIZING  
RANDOM NUMBER GENERATOR FOR SELECTING GAME SYMBOLS

DESCRIPTION

Background of the Invention

The present invention relates to reel-type slot machines, and more particularly to reel-type slot machines having multiple display reels each bearing a plurality of different game symbols, wherein the reels are driven to display game symbols selected for each reel by a random number generator and look-up table.

In recent years reel-type slot machines have evolved from mechanical type machines wherein mechanical clutches were relied on to stop spinning display reels at random locations to display a game result, to electronic type machines wherein a microprocessor randomly selects a game result, and the display reels are driven to reel positions wherein game symbols on the reels display the game result. The present invention is directed to an improvement in such an electronic type slot machine wherein a random number generator randomly selects a number within a predetermined set of random numbers, the randomly selected number is associated with a game symbol for each reel within a look-up table, and each reel is positioned to display its respective game symbol. By

providing a greater number of random numbers in the random number set than the number of available sets of different symbol combinations which can be displayed on the reels, and by varying the sizes of the subsets of random numbers which correspond to each different set of game symbols, the odds of a particular game result occurring can be predetermined for the machine.

In electronic reel type slot machines the reels are typically positioned by stepper motors, which may be contained in removable modules within the machine. The stepper motors respond to applied signals which are progressively phase-shifted relative to each other such that the stepper motors are caused to turn one element of rotation for each progression of the phase signals.

The phase signals are typically generated in motor drive circuits, which respond to applied motor stepping pulses to advance the reels in increments. The motor stepping pulses are generated by a microprocessor, a predetermined number of pulses being generated to cause each motor to be incremented to a selected stopping position wherein the game result is displayed by the display reels. In practice, the stopping positions were determined by the microprocessor by either counting the number of motor pulses occurring after a "home" marker on the reel had passed a fixed sensor, or by counting markers provided on the reel for each symbol position after the home marker had passed.

In contrast, the present invention is directed to a reel-type slot machine wherein in response to a play command the microprocessor selects a random number within a predetermined set of random numbers, the selected random

number is associated with game symbols within a memory device providing a look-up table, and the display reels are rotated to display the game symbols.

5 Accordingly, it is a general object of the present invention to provide a new and improved reel-type slot machine.

10 It is a more specific object of the present invention to provide a reel-type slot machine wherein game symbols to be displayed are selected by a random number generator operating in conjunction with a look-up table, and the display reels are driven by stepper motors to display the selected game symbols.

#### Summary of the Invention

15 The invention is directed to a slot machine comprising a rotatably mounted reel containing a plurality of game symbols, a stepper motor having a drive shaft rotatably coupled to the reel, a game control circuit responsive to a play command for randomly picking a random  
20 number, utilizing the random number in a look-up table to select game symbols, and causing the stepper motors to drive the reels to display the selected symbols.

#### Brief Description of the Drawings

25 The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with the further objects and advantages thereof, may best be understood by reference to the following description taken  
30 in conjunction with the accompanying drawings, in the several figures of which like reference numerals identify

like elements, and in which:

Figure 1 is a perspective view of a reel-type slot machine constructed in accordance with the invention.

5 Figure 2 is a perspective view of the slot machine of Figure 1 with its cabinet open to show the principal components of the machine.

Figure 3 is a perspective view of one of the removable reel assemblies utilized in the slot machine of Figures 1 and 2.

10 Figure 4 is an enlarged exploded view of the reel assembly of Figure 3.

Figure 5 is an enlarged front view of the reel assembly of Figures 3 and 4.

15 Figure 6 is a side cross-sectional view of the reel assembly taken along line 6-6 of Figure 5.

Figure 7 is a functional block diagram illustrating the operation of the slot machine of Figures 1 and 2.

20 Figure 8 is an illustration of a representative arrangement of game symbols and game symbol-indicating indicia on the three display reels of the slot machine of Figures 1 and 2.

25 Figure 9 is a simplified schematic diagram partly in functional form illustrating the operation of the slot machine of Figures 1 and 2.

Figures 10A-10E depict a table showing the association between random numbers and game results in the slot machine of Figures 1 and 2.

30 Figure 11 illustrates an EPROM for implementing the table of Figures 10A-10E.

Figure 12 illustrates the data content of the

EPROM of Figure 11.

Figure 13 illustrates an alternate form of EPROM for implementing the table of Figures 10A-10E.

Figure 14 illustrates the data content of the EPROM of Figure 13.

Figure 15 is a flow chart illustrating the use of the EPROM of Figure 13 in the slot machine of Figures 1 and 2.

Figure 16 is an enlarged exploded view of an alternate form of the reel assembly of Figure 3.

Figure 17 is a cross-sectional view of the reel assembly of Figure 16 taken along line 17-17 of Figure 16.

Figure 18 is an illustration of a representative arrangement of game symbols and game symbol-indicating indicia on the alternate form of reel assembly of Figures 16 and 17.

Figure 19 is a simplified schematic partially in functional block form illustrating the operation of a slot machine utilizing the alternate reel assembly of Figures 16-18.

Figure 20 is an enlarged schematic diagram of a portion of the functional block diagram of Figure 19.

Figure 21 is a simplified schematic diagram of the ramp-up circuit utilized in the slot machine of Figure 19.

Figure 22 is a simplified schematic diagram of the ramp down-circuit utilized in the slot machine of Figure 19.

### 30 Description of the Preferred Embodiment

Referring to the drawings, and particularly to

Figures 1 and 2, a reel-type slot machine 20 constructed in accordance with the invention is seen to include a cabinet 21 having a display window 22. Game symbols 23-25 contained on respective reels 26-28 (Figure 2) of individual plug-in reel assemblies 30-32 are visible on a pay line 29 through the window. It will be understood that the slot machine can be constructed with a greater or lesser number of display reels.

In accordance with conventional design slot machine 20 includes a coin slot 33 (Figure 1) for receiving coins, a tray 34 for dispensing coins, and a user-actuated play handle 35 for initiating game play. Within cabinet 21 slot machine 20 further includes a coin dispensing unit 36 (Figure 2) of conventional design and an electronic game control module 37 for controlling game operation. As will be described presently, this module among its other control functions provides drive signals to reel assemblies 30-32 to cause reels 26-28 to display game symbols corresponding to a particular game result on pay line 29.

Referring to Figures 3-6, reel assembly 30, which may be identical to the other reel assemblies except possibly for its symbol make-up, is seen to include a stepper motor 40 having a shaft 41 on which display reel 26 is received. The reel includes an outer rim portion 42 on which game symbols 23 are contained, and an inner rim portion 43 concentric with the outer portion on which symbol-indicating indicia in the form of a plurality of apertures 44 arranged side-by-side in three columns. The two reel portions 42 and 43 are carried on shaft 41 at a fixed angular position relative to each other. In a



preferred form, the entire display reel 26 is formed as a single piece which can be conveniently installed on and removed from shaft 41. A flat 45 may be formed on shaft 41 to provide positive rotational coupling between stepper motor 40 and the reel.

A generally A-shaped frame 46 is provided to position motor 40 such that one symbol position on the outer rim portion 42 can be seen on pay line 29 through window 22 when reel assembly 30 is installed in cabinet 21. A detector assembly 47 on frame 46 operates in conjunction with the indicia 44 on the inner rim portion 43 to identify the game symbols as they approach window 22. An electrical connector 48 is provided on one leg of frame 46 to enable electrical connections to be made with the reel assembly when the reel assembly is installed in cabinet 21.

As shown in Figure 6, reel 26 includes a hub portion 49 which is received over motor shaft 41. An aperture 50 in the hub portion receives the motor shaft. A spring 51 within the hub portion engages the flat 45 on the shaft to secure the hub on the shaft, and prevent independent reel rotation. Alternatively, a set screw may be provided in the hub portion for the same purpose.

Detector assembly 47 is seen in Figure 6 to include a housing having two projecting portions 52 and 53 which form a slot 54 through which the inner rim portion 43 passes. The upper portion 52 includes three light sources in the form of LEDs 55a-55c and the lower portion 53 includes three photodetectors 56a-56c. LEDs 55a-55c and detectors 56a-56c are aligned with rim portion 43 such that the three columns of symbol-indicating apertures 44

contained thereon pass between respective paired LEDs and detectors with rotation of the reel. In this way, the passage of each set of apertures is sensed, and, in a manner to be explained, the game control circuits  
5 determine when a particular game symbol is about to be displayed in window 22.

The basic operation of slot machine 20 is functionally illustrated in Figure 7. First, at 60 a coin is received. Then, at 61, if the machine has not been  
10 inhibited as a result of a malfunction or tampering, the microprocessor-driven game control circuits, utilizing a conventional stored algorithm, generate a random number within a predetermined range of random numbers. For example, in a 28 bit system the number may be one of  
15 268,435,456 numbers in a range of 0 to 268,435,455. Then, at 62 this number is utilized in conjunction with a stored look-up table in an EPROM or similar memory device to select a game result comprising, in this three reel embodiment, three game symbols SYM1, SYM2 and SYM3.

20 Next, at 63 all three reels are caused to spin. The first reel 26 continues to spin for a first predetermined free spin period, typically one second, and upon completion of this period at 64 a stopping procedure is initiated at 65 whereby signals developed by the game  
25 symbol-indicating apertures 44 passing detector 47 are compared with signals corresponding to the desired game symbol SYM1. When a comparison is realized, the application of normal drive signals to stepper motor 40 is interrupted and a stop routine is initiated at 66 to stop  
30 the display reel with the desired symbol displayed.

In the meantime the second display reel 27

continues to spin, and upon completion of a second predetermined spin period, also typically one second, at 67 following the stopping of reel 26 the signals generated by the symbol-indicating apertures on reel 2 are compared at 68 with signals corresponding to the desired game symbol SYM2 for reel 27, and upon occurrence of a comparison a stop routine is initiated at 69 to cause reel 27 to stop with the desired game symbol for that reel displayed. Similarly, the third display reel 28 continues to spin through a third one second predetermined free spin period at 70 following the stopping of reel 27 until at 71 a comparison of the signals generated by the symbol-indicating apertures 44 thereon with a signal corresponding to the desired symbol to be displayed on the reel is obtained and a stop routine 72 causes the reel to stop with the intended game symbol displayed through window 22 on pay line 29.

In the event that a spin error has occurred in the positioning of any one of the three reels, either as a result of the stepper motor slipping or failing to step in response to a stepper pulse, or a reel having been moved in the absence of stepper pulses, the monitoring system signals a spin error at 73, an alarm is sounded and the game is inhibited at 74. In the absence of a spin error, a determination is made at 75 whether the game results constitute a win, and if so the hopper mechanism 36 is actuated to accomplish a payout at 76.

One form of display reel make-up is shown in Figure 8. Here each of the three display reels 26-28 has 22 display positions, containing 11 blanks and 11 symbols. The symbols and blanks appear on the outer rim portions 42

of the reels in alternation, a blank space appearing between each pair of consecutive game symbols.

Indicia comprising a three bit binary code is associated with each symbol by the provision of thin slit-shaped apertures on the inner rim portion 43 of each display reel. These binary codes are unique to their associated symbol or blank, and are arranged in three columns A-C around the reel rim portions 43.

Although for clarity no angular displacement is shown between the symbols and their associated codes, in practice the angular displacement of the leading edge of the codes to the symbols may range from  $0^{\circ}$  to  $180^{\circ}$ , depending on the location of sensors 47 relative to the pay line, and on the angular rotation required to stop the reel. In the illustrated embodiment, for example, where the sensors are displaced  $115^{\circ}$  from the pay line, if the stepper motor is large and requires a relatively small number of steps per rotation, 48 for example, the stop is essentially instantaneous and the displacement is  $115^{\circ}$ . However, if a ramp down procedure such as that to be later described is used, and the ramp-down routine requires, for example,  $40^{\circ}$  of rotation, the displacement is  $155^{\circ}$  ( $115^{\circ} + 40^{\circ}$ ).

While the illustrated reel set shows 22 symbol positions with 11 blank spaces and 11 game symbols of 6 different types (e.g., for reel 30; two triple bars, two double bars, two single bars, two cherries, 3 sevens), it will be appreciated that a greater or lesser number of symbol positions can be provided with a greater or lesser number of symbols and symbol types.

The functioning of slot machine 20 is

illustrated in Figure 9. Game control circuits 37 (Figure 2), which typically include a microprocessor and associated memory and input-output circuits depicted functionally in Figure 9 as game circuits 77, receive  
5 signals from a conventional coin-in detector 180 and a conventional spin switch 181, which may be either a panel-mounted push button switch or a switch actuated by play handle 35. The microprocessor, utilizing a stored random number generating algorithm, the function of which is  
10 generally designated in Figure 9 by a random number generator 78 (RNG), generates a random number which may be, for example, in a 28 bit system one of 268,435,456 possibilities within a predetermined range of 0 to 268,435,455. This number is applied to a memory device  
15 79, preferably taking the form of a plug-in EPROM 79, in which a look-up table has been stored.

The look-up table contains a specific game result in the form of a blank or game symbol (7, bar, double bar, triple bar, or cherry) for each reel for each  
20 applied random number. The game result symbols are each separately output from the EPROM as a three bit binary signal which is applied to a respective one of three comparators 80-82.

When enabling signals are applied to AND gates  
25 84-86, stepper pulses generated by a clock 83 and a divider 87 are applied to individual motor phase signal generating circuits 88-90 associated with reel assemblies 30-32, respectively. Circuits 88-90 provide progressively advancing quadrature phase signals in response to the  
30 applied stepper pulses to stepper motor drive circuits 91-93, respectively. The outputs of each drive circuit are

applied to the four stator windings of the associated stepper motor 40 in a conventional manner whereby the stepper motor is caused to incrementally rotate in response to each stepper pulse.

5           As display reels 26-28 rotate the detectors 47 associated with each reel read the game symbol-indicating apertures 44 on the reels. Upon completion of the respective free spin periods of the reels, signals developed by detectors 47 from the passing apertures 44  
10 are compared in comparators 80-82 with signals corresponding to the desired game result symbols, as supplied to those comparators by the look-up table in EPROM 79. When a comparison is realized, an inhibit signal is applied by the corresponding comparator through  
15 respective ones of AND gates 94-96 and invertors 97-99 to AND gates 84-86, respectively, the application of normal stepper pulses to the corresponding one of motor phase signal circuits 88-90 is interrupted, and the corresponding reel is stopped, either abruptly by force of  
20 the motor or by a ramp-down procedure to be described. Once the reels have stopped, if the game result for the generated random number is a win, an appropriate signal indicative of the pay-out amount is generated by EPROM 79 and applied to hopper mechanism 36 to pay out the  
25 appropriate number of coins.

          It will be understood that each of the reel assemblies, except for the symbol make-up of their individual reels 26-28, which may or may not be the same, may be identical in construction and operation.  
30 Similarly, each of the three motor drive circuits 91-93 may be identical in structure and operation.

To achieve the necessary free-spin periods for reels 26-28, game control circuits 77 include three delay circuits 100-102. Delay circuit 100, which is triggered by actuation of spin switch 181 through an inverter 103, may provide a delay, for example, of approximately one second. During this delay period AND gate 94 is inhibited by the delay circuit, preventing the application of a stop signal from comparator 80 to AND gate 84 through inverter 97. Delay circuit 101, which is triggered by the stop signal at the output of AND gate 94, similarly prevents the output of comparator 81 from inhibiting AND gate 85 through inverter 98 for approximately one second following the stopping of display reel 26. Delay circuit 102 in like manner prevents the output of comparator 82 from inhibiting AND gate 86 for one second following the stopping of display reel 27.

Protection against tampering or malfunction is provided by an RS flip-flop 104 which is set by the output of AND gate 96 when the third reel 28 comes to rest. The  $\bar{Q}$  output of this flip-flop is applied to an AND gate 106, which inhibits the application of stepper pulses to the motor phase signal circuits. The Q output of RS flip-flop 104 is applied through an inverter 107 to a NAND gate 108, which also receives the output of a delay circuit 109 triggered by spin switch 181. In the event the reels have not come to rest within the time period established by delay circuit 109, NAND gate 108 produces an output which is applied through NAND gate 110 to an alarm circuit 111 and through an inverter 112 to an inhibiting input of coin hopper 36.

Further protection against tampering is provided

by an inverter 113 and NAND gate 114, which provide an alarm output through NAND gate 110 if the reels are moved after the reels have stopped and RS flip-flop 104 is set.

While control circuits 77 have been shown and explained in terms of certain logic components, it will be appreciated that the same functionality can be readily obtained by means of a conventional microprocessor using well known programming techniques. For example, in the present embodiment all the functions of circuits 77 can be accomplished using, for example, a type ATMEL 89C2051 microprocessor in conjunction with an appropriate EPROM and conventional and well known peripheral components. Furthermore, while a three reel machine is shown, one or more additional reels can be provided utilizing the control methods described for reels 26-28.

To provide for high odds payouts it is necessary that random number generator 78 be capable of providing random numbers within a wide range of possibilities. In particular, to provide a desirable one million dollar payout on a one dollar bet a probability of less than 0.0000001 is desirable on the winning symbol combination (777 in the present embodiment) providing that payout. Thus, the random number generated by EPROM 79 must be at least 24 bits. To provide additional precision in game play, a 28 bit random number generator is preferably used, providing a range or set of random numbers from 0 to 268,435,455.

A look-up table implementing the 28 bit random number in a representative game having the five different symbols depicted in Figure 7 is shown in Figures 10A-10E. Referring to these Figures, it is seen that 216 different



combinations of the symbols on three reels, i.e., 216 different game results, are possible. Each of the different game results is given a subset within the 0-268,435,455 set of random numbers.

5           Certain winning combinations of symbols (such as "777") are given a low probability and a high payout. Losing combinations may be given a high probability. In the illustrated table, for example, the first 97 losing game results have the same size subset (2,416,822) and  
10           hence the same probability of occurrence (0.009003364) and same zero payout. Winning game results in the table, depending on the particular symbols being displayed, have lesser probabilities. For example, game result 143, which displays three cherries, has a subset or weight of  
15           1,584,515 possibilities, a probability of occurrence of 0.005902778, and a payout of 12 times the bet. Game result 195, the "777" jackpot, has a subset with a weight of 19, a probability of occurrence of 0.000000071, and a payout of 1,000,000 times the bet.

20           Thus, the look-up table embodied in EPROM 79 provides the game designer a high degree of flexibility. By varying the size of a subset of random numbers which will give a particular game result, i.e., a particular set of game symbols, the odds of occurrence of that result,  
25           and hence the payout which can be assigned to that result, can be readily set. Since these selections are contained in a replaceable EPROM, the make-up of the game can be easily changed to provide greater or lesser odds (and hence greater or lesser sized payouts), and more frequent  
30           or less frequent payouts. Furthermore, by increasing the size of subsets which provide symbol combinations which

constitute "near wins", i.e., one symbol of the result just one display position away from providing a winning symbol display, the designer can make the game more exciting to the player.

5           Further flexibility is provided to the designer by the construction of the reel assemblies. In particular, since display reels 26-28 can be readily removed from their associated motor shafts 41 without disturbing the sensor assemblies 47, an operator can  
10       change reel makeup at the same time he changes EPROM 79, allowing for a completely different game to be installed.

          A 262M x 29 EPROM 120 suitable for use in implementing the look-up table of Figures 10A-10E in control circuits 77 is shown in Figures 11 and 12. The 28  
15       bit random number generated by random number generator 78 is entered on pins A $\phi$ -A27. Symbols SYM1, SYM2 and SYM3 for reels 26-28 are derived on pins 0 $\phi$ -02, 03-05, and 06-08, respectively. The payout (0-1,000,000), requiring 20 bits, is provided on pins 09-028.

20           Thus, as shown in Figure 12, for any 28 bit input of a random number, EPROM 120 provides on its output pins three three bit binary numbers representing the three game symbols of the game result, and one 20 bit number representing the payout for that game result.

25           While the 262MX29 EPROM 120 of Figure 11 would provide satisfactory results, a more efficient implementation of the look-up table in a 2KX8 EPROM 121 is shown in Figures 13-15. In particular, the look-up table in the 2KX8 EPROM 121 is condensed to require only eight  
30       bytes for each of the 216 possible game results. The first three bytes (24 bits) encode the weight of the

subset (the span between the "From" and "To" entries in Figures 10A-10E). Two bytes (16 bits) encode the game results (the three game symbols, 3 bits for each reel), and three bytes (24 bits) encode the amount of payout (up to 16,777,215 times the bet, if all 24 bits are used). Thus, each consecutive block of eight bytes in the EPROM represent a single line entry, as shown in Figure 14. The total size of the EPROM need be only 1728X8.

The method of accessing the condensed look-up table in EPROM 121 is shown in Figure 15. First, a 28 bit random number is generated at 61 as previously described. Then, at 122 the first EPROM address is accessed. At 123 the first three bytes beginning at that address are assembled into a 24 bit number representing the size or weight of the subset represented by the address. If the random number is greater than the accessed subset weight at 124, then at 125 the subset weight is subtracted from the random number and the next table entry is accessed at 126. The weight of the subset represented by this address is obtained by combining the first 3 bytes beginning at that address into a 24 bit number. This number is compared with the previously modified random number at 124. If the modified random number is greater, then the weight is again subtracted and the look-up procedure is repeated.

If the random number is less than the subset weight derived from the table, the next two bytes of the accessed data are utilized at 127 to specify the game result, i.e., the game symbols to be displayed by the three display reels (3 sets of 3 bits each). The last three bytes (24 bits) are combined at 128 to specify the payout amount, if any. The game results and payout being

specified, the routine ends at 129 and the reels are repositioned to display the game results, as previously described.

Thus, the procedure outlined in Figure 15  
5 enables a much smaller and less expensive EPROM to be used in slot machine 20.

As previously mentioned, where a smaller stepper motor is utilized which provides a larger number of steps per revolution, 200 or 400 steps for example, it may be  
10 preferable to incorporate ramp-up and ramp-down routines in the starting and stopping of the display reels to prevent the stepper motors from slipping, i.e., failing to step in response to a stepper pulse. With such routines, lower rate stepping pulses are applied to the stepper  
15 motor drive circuits 91-93 for a ramp-up period following a spin command (as when spin button 181 is actuated) and for a ramp-down period following a stop command (as when a comparator generates a stop signal).

Referring to Figures 16-20, an advantageous  
20 construction for obtaining a stop initiating command is to provide an additional set of binary coded indicia 130 (Figure 18) angularly displaced from the symbol-indicating stop indicia associated with the displayed game symbol. This additional stop initiating indicia, which preferably  
25 utilizes the same 3 bit binary coding as the stop command indicia, is differentiated from the stop indicia by the presence of a fourth bit, contained in a fourth column D in Figure 18. The fourth bit may be represented by an aperture which is shorter than the apertures representing  
30 the other three bits so as to act as a strobe bit for greater precision in detecting the passage of the symbol.

code. An additional LED light source 131 and associated photosensor 132 are provided in a sensor assembly 133 (Figure 17) mounted on the reel assembly frame to detect the additional bit.

5           As shown for the three display reels 26-28 in Figure 18, the stop initiating indicia are spaced ahead of the stop-indicating indicia by an angular displacement sufficient to allow the display reel to be ramped down to a slow stopping speed prior to the reel reaching the stop  
10 position. When the reel reaches the stop position, as signaled by the stop-indicating indicia, the application of the slow stepping pulses is interrupted and the reel abruptly stops.

          In practice, for a 200 step motor operating at 2  
15 revolutions per second, 45 stepping pulses may be utilized in slowing the motor to a desirably slow stopping speed. This results in the stop-initiating indicia being located approximately two and one-half symbol display positions ahead of the stop-indicating indicia, as shown in Figure  
20 18.

          Referring to Figures 19 and 20, three ramp-down circuits 135-137 provide decreasing rate stepping pulses to stepper motor drive circuits 91-93 during the stopping routine, and a single ramp-up circuit 138 provides  
25 increasing rate stepper pulses during the starting routine. The operation of the ramp-down circuits is controlled by three RS flip-flops 139-141, which initiate the ramp-down routine, and three RS flip-flops 142-144, which stop the reels. The operation of ramp-up circuit  
30 138 is controlled by spin switch 181.

          Upon actuation of spin switch 181, all six RS

flip-flops 139-144 are reset. The  $\bar{Q}$  outputs of flip-flops 139-141 enable three AND gates 145-147, which allow stepper pulses developed by ramp-up circuit 138 to be applied to the three stepper motor phase signal circuits 88-90. At the same time, the  $\bar{Q}$  output of RS flip-flop 104, which is reset by spin switch 181, causes ramp-up circuit 138 to initiate the ramp-up routine.

When the ramp-up routine is complete, circuit 138 provides an output to delay circuit 100, which times the free-spin period of reel 26 as previously described. After this free-spin period, AND gate 94 is enabled to allow the output of comparator 80 to initiate a stop routine. As before, comparator 80 is looking for a match with the symbol indicia provided by EPROM 79. However, the  $\bar{Q}$  output of RS flip-flop 139, in its reset state, requires that the fourth bit associated with stop-initiating indicia also be present for a match. This prevents the comparator from responding to stop-indicating symbol indicia passing detector 133, and allows the comparator to respond to stop-initiating indicia on reel 26.

When a match is recognized by comparator 80, RS flip-flop 139 is set, and AND gate 145 is inhibited to prevent stepper pulses from the ramp-up circuit 138 from being applied to motor phase signal circuits 88. At the same time, the Q output of RS flip-flop 139 enables an AND gate 148, allowing pulses from ramp-down circuit 135 to be applied to stepper motor drive circuits 91 through an OR gate 149. Since the  $\bar{Q}$  output of flip-flop 139 no longer requires comparator 80 to sense the fourth bit, the comparator responds to the next-occurring stop-indicating

symbol indicia to provide a signal which is applied through an AND gate 150, upon receipt of a stop enabling signal from ramp-down circuit 135, to set RS flip-flop 142, which inhibits AND gate 148 to prevent further application of pulses to stepper motor drive circuits 91. Lack of the stop enabling signal from ramp-down circuit 135 prevents RS flip-flop 142 from being set by the comparison output which occurs with passage of the stop-initiating symbol indicia or with passage of any stop-indicating symbol indicia prior to the completion of a substantial portion of the ramp-down. Delay circuit 101 is actuated when RS flip-flop 142 is set to initiate the free spin period for display reel 27.

Display reels 27 and 28 are controlled in a similar manner by RS flip-flops 140 and 141, which initiate the ramp-down routine, and RS flip-flops 143 and 144, which stop the reels in conjunction with AND gates 151-154 and OR gates 155 and 156 (Figure 20).

The function of RS flip-flop 104 is as previously described, except that the device is set by the output of an AND gate 157, which provides a set signal when all three comparators 80-82 indicate a match (i.e., when all three display reels are displaying the game result symbols called for by EPROM 79) and RS flip-flop 144 is set, indicating that the third reel has stopped. When these conditions are fulfilled, RS flip-flop 104 is set and NAND gate 114 is enabled, so that any subsequent change in state of AND gate 157, as by movement of a reel, causes activation of alarm 111.

Referring to Figure 21, one form of ramp-up circuit 138 suitable for use in slot machine 20 is seen to

include three counters 160-162, a comparator 163, and an RS flip-flop 164. While the start signal is false, all three counters are held in reset and RS flip-flop 164 is reset. Upon actuation of spin switch 181, the start  
5 signal is true and counter 160 counts applied clock pulses until a count of 16 is reached, at which time the counter produces an output which inhibits further counting by the counter and enables counter 161 to count clock pulses. Counter 161 continues to count from zero until its output,  
10 applied inverted to comparator 163, compares to the initial zero count in counter 162. Initially, this does not occur until counter 161 has counted to its capacity count of 63, producing all logic 1's which when inverted match the all logic 0's of counter 162.

15 When a match is recognized by comparator 163, an output of the comparator sets RS flip-flop 164, producing at the Q output of that device a stepping pulse for application to the stepper motor phase circuits, and at the  $\bar{Q}$  output a signal which increments counter 162 one  
20 count.

The Q output of RS flip-flop 164 also resets counters 160 and 161, allowing counter 160 to again count clock pulses. With the next negative transition of the clock pulse, RS flip-flop 164 is reset and counter 162 is  
25 advanced one count. When counter 160 again reaches its maximum count of 16, counter 161 is again enabled and begins counting clock pulses. Since there is now a one count in counter 162, counter 161 needs only to count to 62 before its inverted output compares with the non-  
30 inverted output of counter 162 and comparator 163 produces an output which resets RS flip-flop 164. As before, this



produces a stepping pulse for application to the stepper motor phase circuits, an increment of one count in counter 162, and a reset of counters 160 and 161.

In this manner, stepping pulses are produced with linearly increasing frequency as counter 161 counts to progressively lower counting states to match the progressively increasing counting state of counter 162. In practice, the ramp-up circuit may initially produce stepping pulses at 160 hertz, ramping-up in 64 linear steps to a pulse rate of 800 hertz, which it continues to produce until a subsequent start signal is received. With a nominal clock frequency of 12.8 KHz, this results in a ramp-up speed starting at 0.4 RPS and increasing to 2.0 RPS.

The functioning of ramp-down circuit 135 is similar to ramp-up circuit 138 except that the outputs of counter 161 are applied to comparator 163 non-inverted.

Referring to Figure 22, one form of ramp-down circuit 135 suited for use in slot machine 20 is seen to include three counters 170-172, a comparator 173 and an RS flip-flop 174. While the start signal is false, all three counters are held in reset and RS flip-flop 174 is reset. Upon actuation of spin switch 181, the start signal is true and counter 170 counts applied clock pulses until a count of 16 is reached, at which time the counter produces an output which inhibits further counting by the counter and enables counter 171 to count clock pulses. Counter 161 continues to count from zero until its output, applied to comparator 173, compares to the initial zero count in counter 172. Initially, this occurs immediately, causing the comparator to produce an output which sets RS flip-

flop 174, producing at the Q output of that device a stepping pulse for application to the stepper motor phase circuits, and at the  $\bar{Q}$  output a signal which increments counter 172 one count.

5           The Q output of RS flip-flop 174 also resets counters 170 and 171, allowing counter 170 to again count clock pulses. With the next negative transition of the clock pulse, RS flip-flop 174 is reset and counter 172 is advanced one count. When counter 170 again reaches its  
10           maximum count of 16, counter 171 is again enabled and begins counting clock pulses. Since there is now a one count in counter 172, counter 171 needs to count to 1 before its output compares with the output of counter 172 and comparator 173 produces an output which resets RS  
15           flip-flop 164. As before, this produces a stepping pulse for application to the motor phase circuits, an increment of one count in counter 172, and a reset of counters 170 and 171. This cycle continues until counter 172 reaches its maximum counting state of 43, as determined by an AND  
20           gate 175, at which time counter 172 is no longer incremented and RS flip-flop 174 is regularly toggled at a fixed slow rate as counter 171 repeatedly counts to 63.

          In this manner, stepping pulses are produced with linearly decreasing frequency as counter 171 is  
25           required to count to progressively higher counting states to match the progressively increasing counting state of counter 172. In practice, the ramp-down circuit may initially produce stepping pulses at 800 hertz, and ramp-down in 45 linear steps to a pulse rate of 210 hertz, at  
30           which rate it continues to produce pulses until a stop signal is received. With a nominal clock frequency of

12.8 KHz, this results in a ramp-down speed starting at 2 RPS and ending at 0.4 RPS.

While the ramp-up and ramp-down functions of this alternate embodiment of the invention have been  
5 illustrated using discrete logic components, it will be appreciated that all of the same functions and results can be advantageously performed by a conventional microprocessor using well known conventional programming techniques.

10 A slot machine has been shown and described wherein a random number generator generates a random number, an EPROM assigns a game result consisting of a game symbol or space for each reel, and the reels are stopped to display the game result when the associated  
15 game symbol passes a sensor. By changing the EPROM, the odds of a particular game can be quickly and easily changed by a technician.

While particular embodiments of the invention have been shown and described, it will be obvious to those  
20 skilled in the art that changes and modifications may be made therein without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

Claims

1. A reel-type slot machine comprising:

at least one display reel having a plurality of  
different game symbols thereon, said display reel  
being rotatably mounted to selectively display one of  
said game symbols;

reel drive means responsive to an applied control  
effect for rotatably driving said display reel;

selection means responsive to a play command for  
randomly selecting one random number from a  
predetermined set of random numbers;

means for assigning a game symbol to each random  
number within said set of random numbers; and

display control means for causing said reel  
drive means to display the game symbol assigned to  
said selected random number.

2. A reel-type slot machine as defined in claim 1  
wherein said display reel has a predetermined number  
of different game symbols which is less than the  
number of random numbers within said predetermined  
set of random numbers.

3. A reel-type slot machine as defined in claim 2  
wherein said display reel contains at least two of  
each of said different game symbols.

4. A reel-type slot machine as defined in claim 1  
wherein said display reel includes indicia fixedly  
positioned on said reel for identifying each of said  
game symbols thereon, and said display control means

is responsive to said indicia.

5. A reel-type slot machine as defined in claim 4 further including indicia detection means fixedly positioned relative to said display reel for detecting the passage of said game symbols, said display control means being responsive to said indicia detection means for stopping said display reel to display said assigned game symbol.
6. A reel-type slot machine as defined in claims 4 or 5 wherein said display reel has at least five different symbols and said indicia comprises at least three binary digits.
7. A reel-type slot machine as defined in claim 1 wherein said reel drive means comprise a stepper motor.
8. A reel-type slot machine as defined in claim 7 wherein said reel drive means is responsive to applied stepping pulses, and said display control means interrupt said stepping pulses to stop said display reel.
9. A slot machine as defined in claim 1 wherein said selection means comprise a random number generator and said means for assigning a game symbol comprises a memory device containing a look-up table responsive to said selected random number.

10. A slot machine as defined in claim 9 wherein said memory device comprises an EPROM.
11. A reel type slot machine as defined in claim 1  
5 wherein each of said different game symbols is associated with a predetermined subset of random numbers within said predetermined set of random numbers, the size of said subsets determining the probability of respective ones of said game symbols  
10 being displayed.
12. A reel type slot machine as defined in claim 11 wherein said machine has multiple display reels each having a plurality of different game symbols thereon,  
15 said assigning means assign a respective game symbol for display to each of said display reels, and said display control means cause each of said display reels to display the game symbol assigned to that reel.
- 20 13. A reel-type slot machine comprising:  
at least one display reel having a plurality of different game symbols thereon, said display reel being rotatably mounted to selectively display one of  
25 said game symbols, and including indicia thereon indicative of the game symbol to be displayed;  
reel drive means responsive to an applied control effect for rotatably driving said display reel;  
30 selection means responsive to a play command for randomly selecting one random number from a

predetermined set of random numbers;

means for assigning a game symbol to each random number within said set of random numbers;

indicia detection means fixedly positioned relative to said display reel for detecting the passage of said game symbols; and

display control means responsive to said indicia detection means for causing said reel drive means to display the game symbol assigned to said selected random number.

14. A reel-type slot machine as defined in claim 13 wherein said display reel has a predetermined number of different game symbols which is less than the number of random numbers within said predetermined set of random numbers.
15. A reel-type slot machine as defined in claim 14 wherein said display reel contains at least two of each of said different game symbols.
16. A reel-type slot machine as defined in claim 13 wherein said display reel has at least five different symbols and said indicia comprises at least three binary digits.
17. A reel type slot machine as defined in claim 13 wherein each of said different game symbols is associated with a predetermined subset of random numbers within said predetermined set of random numbers, the size of said subsets determining the

probability of respective ones of said game symbols being displayed.

18. A reel type slot machine as defined in claim 17  
5 wherein said machine has multiple display reels each having a plurality of different game symbols thereon, said assigning means assign a respective game symbol for display to each of said display reels, and said display control means position each of said display  
10 reels to display the game symbol assigned to that reel.

19. A reel-type slot machine comprising:

at least one display reel having a plurality of  
15 different game symbols thereon, said display reel being rotatably mounted to selectively display one of said game symbols;

reel drive means responsive to an applied  
control effect for rotatably driving said display  
20 reel;

a random number generator responsive to a play  
command for randomly selecting one random number from  
a predetermined set of random numbers;

a memory device defining a look-up table  
25 responsive to said selected random number for assigning a game symbol to said random number within said set of random numbers; and

display control means for causing said reel  
drive means to position said display reel to display  
30 the game symbol assigned to said selected random number.



20. A reel-type slot machine as defined in claim 19  
wherein said display reel has a predetermined number  
of different game symbols which is less than the  
number of random numbers within said predetermined  
set of random numbers.
21. A reel-type slot machine as defined in claim 20  
wherein said display reel contains at least two of  
each of said plurality of different game symbols.
22. A reel-type slot machine as defined in claim 19  
wherein said display reel includes indicia fixedly  
positioned on said reel for identifying each of said  
game symbols thereon, and said display control means  
is responsive to said indicia.
23. A slot machine as defined in claim 19 wherein said  
memory device comprises an EPROM.
24. A reel type slot machine as defined in claim 19  
wherein each of said different game symbols is  
associated with a predetermined subset of random  
numbers within said predetermined set of random  
numbers, the size of said subsets determining the  
probability of respective ones of said game symbols  
being displayed.
25. A reel type slot machine as defined in claim 24  
wherein said machine has multiple display reels each  
having a plurality of different game symbols thereon,  
said assigning means assign a respective game symbol

for display to each of said display reels, and said display control means position each of said display reels to display the game symbol assigned to that reel.

5

26. A reel-type slot machine comprising:

at least one display reel having a plurality of different game symbols thereon, said display reel being rotatably mounted to selectively display one of said game symbols, and including indicia thereon indicative of the game symbol to be displayed;

10

reel drive means responsive to an applied control effect for rotatably driving said display reel;

15

a random number generator responsive to a play command for randomly selecting one random number from a predetermined set of random numbers;

a memory device defining a look-up table responsive to said selected random number for assigning a game symbol to said selected random number; and

20

display control means responsive to said indicia detection means for causing said reel drive means to display the game symbol assigned to said random number.

25

27. A reel-type slot machine as defined in claim 26 wherein said display reel has a predetermined number of different game symbols which is less than the number of random numbers within said predetermined set of random numbers.

30

28. A reel-type slot machine as defined in claim 27 wherein said display reel contains at least two of each of said different game symbols.

5 29. A reel-type slot machine as defined in claim 26 wherein said display reel has at least five different symbols and said indicia comprises at least three binary digits.

10 30. A reel-type slot machine as defined in claim 26 wherein said reel drive means comprise a stepper motor.

15 31. A reel-type slot machine as defined in claim 30 wherein said reel drive means is responsive to applied stepping pulses, and said display control means interrupt said stepper pulses to position said display reel.

20 32. A slot machine as defined in claim 26 wherein said memory device comprises an EPROM.

25 33. A reel type slot machine as defined in claim 26 wherein each of said different game symbols is associated with a predetermined subset of random numbers within said predetermined set of random numbers, the size of said subsets determining the probability of respective ones of said game symbols being displayed.

30

34. A reel type slot machine as defined in claim 33

wherein said machine has multiple display reels each having a plurality of different game symbols thereon, said assigning means assign a respective game symbol for display to each of said display reels, and said display control means position each of said display reels to display the game symbol assigned to that reel.

35. A reel-type slot machine comprising:

at least one display reel having a plurality of different game symbols thereon, said display reel being rotatably mounted to selectively display one of said game symbols;

reel drive means responsive to an applied control effect for rotatably driving said display reel;

selection means responsive to a play command for randomly selecting one random number from a predetermined set of random numbers;

means for assigning a game symbol to each random number within said set of random numbers;

said display reel including indicia associated with and indicative of each of said game symbols carried thereon;

detector means for detecting the passage of said indicia as said display reel rotates to produce a symbol-indicating output signal; and

display control means responsive to said output signal for stopping said reel to display said symbol.

36. A reel-type slot machine as defined in claim 35

wherein said indicia comprise a binary code.

37. A reel-type slot machine as defined in claim 36  
wherein said indicia comprise apertures in said  
display reel.

5

38. A reel-type slot machine as defined in claim 35  
wherein said display reel includes a first annular  
portion containing said game symbols, and a second  
annular portion concentric with said first portion  
containing said indicia.

10

39. A reel-type slot machine as defined in claim 38 .  
wherein said first annular portion is of greater  
diameter than said first portion, and said portions  
are coaxial.

15

40. A reel-type slot machine as defined in claim 39  
wherein said detector means sense the passage of said  
indicia on said second annular portion of said reel.

20

41. A reel-type slot machine as defined in claim 40  
wherein said indicia comprise a binary code.

25

42. A reel-type slot machine as defined in claim 41  
wherein said indicia comprise apertures in said  
display reel.

43. A reel-type slot machine comprising:

30

at least one display reel having a plurality of  
different game symbols thereon, said display reel

being rotatably mounted to selectively display one of said game symbols;

reel drive means responsive to an applied control effect for rotatably driving said display reel;

selection means responsive to a play command for randomly selecting one random number from a predetermined set of random numbers;

means for assigning a game symbol to each random number within said set of random numbers;

said display reel including first and second sets of indicia associated with and indicative of each of said game symbols, said first and second sets of indicia being angularly displaced from each other;

detector means for detecting the passage of said indicia as said display reel rotates to produce a symbol-indicating output signal; and

display control means responsive to said output signal indicating said first set of indicia for slowing the rotation of said reel, and responsive to said output signal indicating said second set of indicia for stopping said reel.

44. A reel-type slot machine as defined in claim 43 wherein said indicia comprise a binary code.

45. A reel-type slot machine as defined in claim 44 wherein said indicia comprise apertures in said display reel.

46. A reel-type slot machine as defined in claim 43

wherein said display reel includes a first annular portion containing said game symbols, and a second annular portion concentric with said first portion containing said indicia.

5

47. A reel-type slot machine as defined in claim 46 wherein said first annular portion is of greater diameter than said first annular portion, and said portions are coaxial.

10

48. A reel-type slot machine as defined in claim 47 wherein said detector means sense the passage of said indicia on said second annular portion of said reel.

15

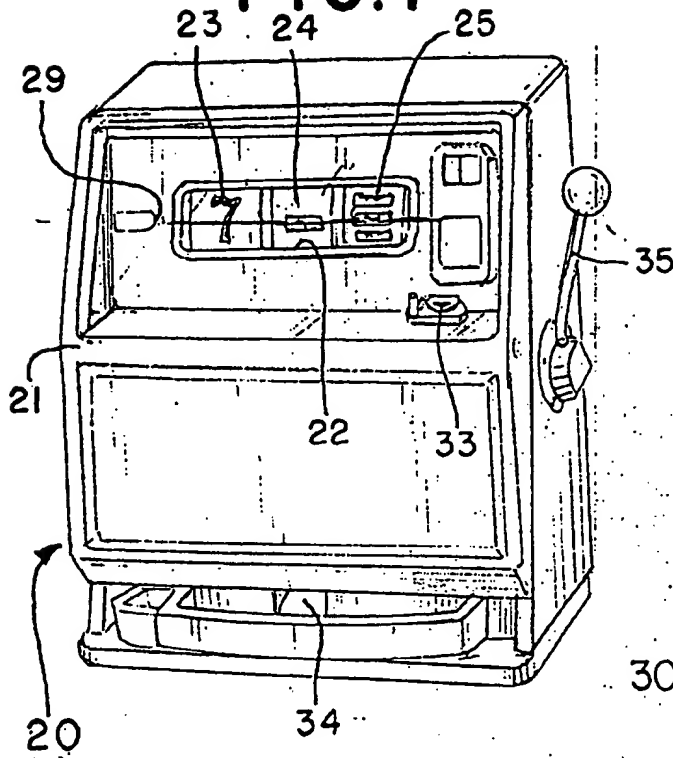
49. A reel-type slot machine as defined in claim 48 wherein said indicia comprise a binary code.

20

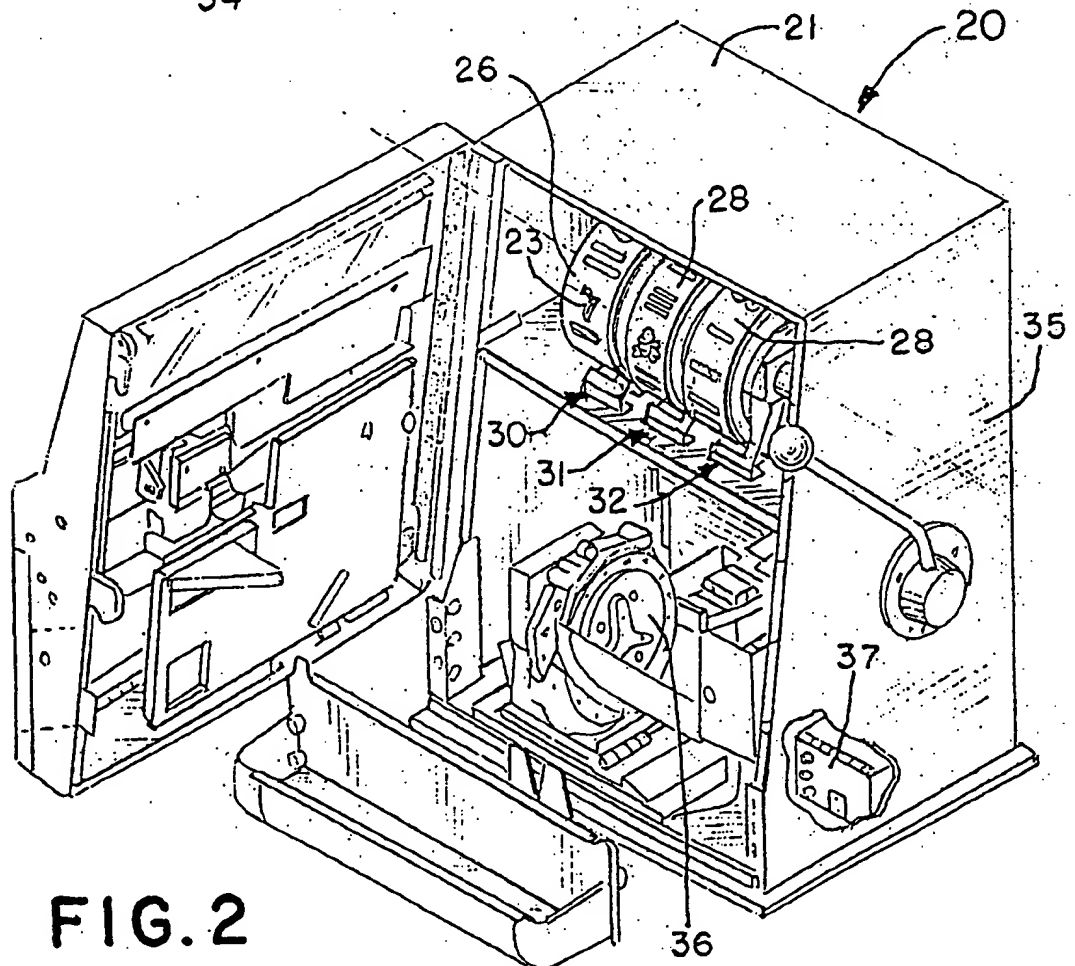
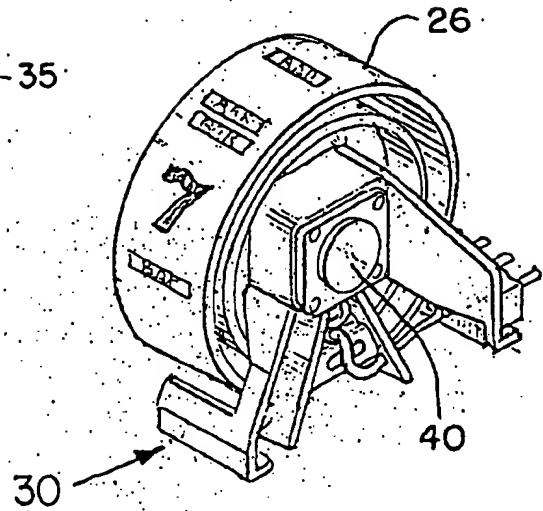
50. A reel-type slot machine as defined in claim 49 wherein said indicia comprise apertures in said display reel.

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**FIG. 1**



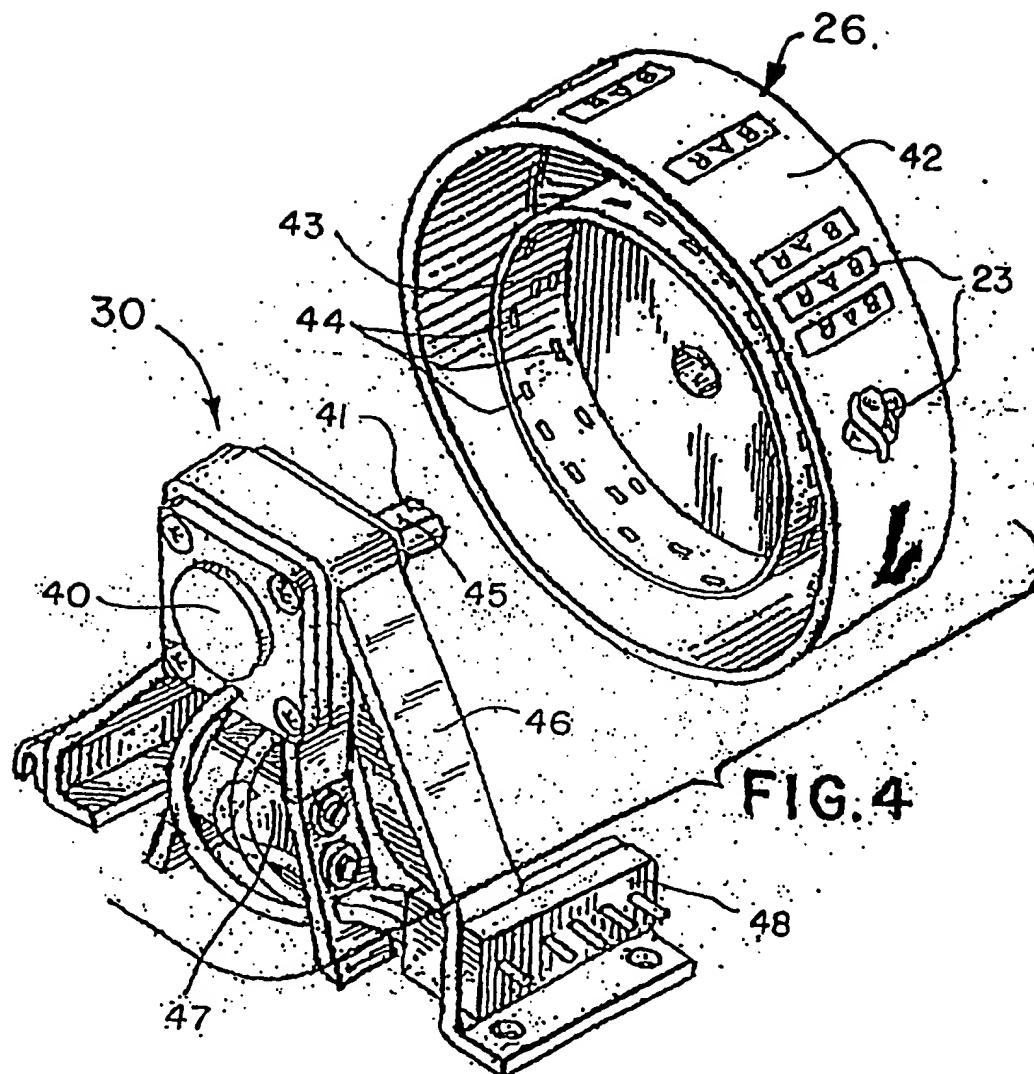
**FIG. 3**



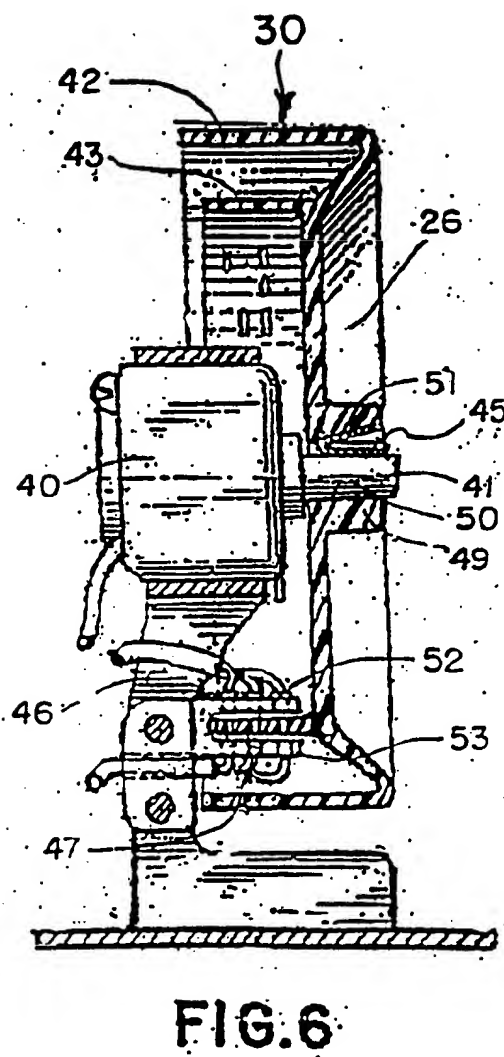
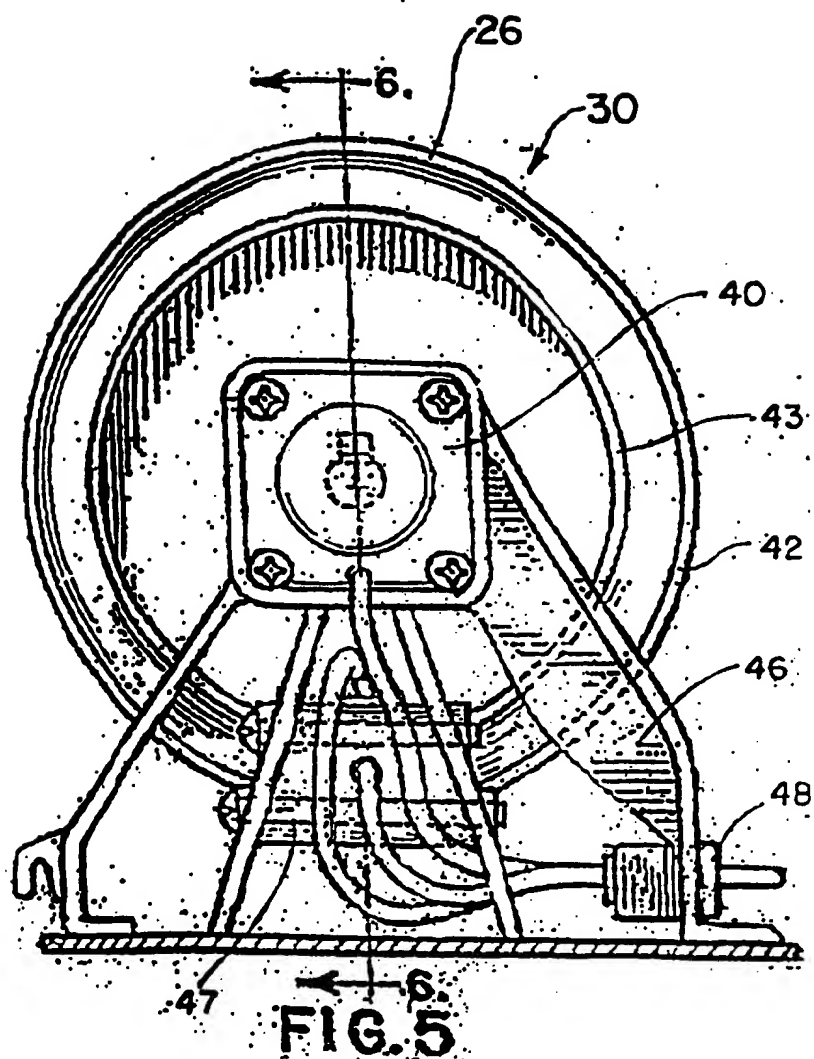
**FIG. 2**



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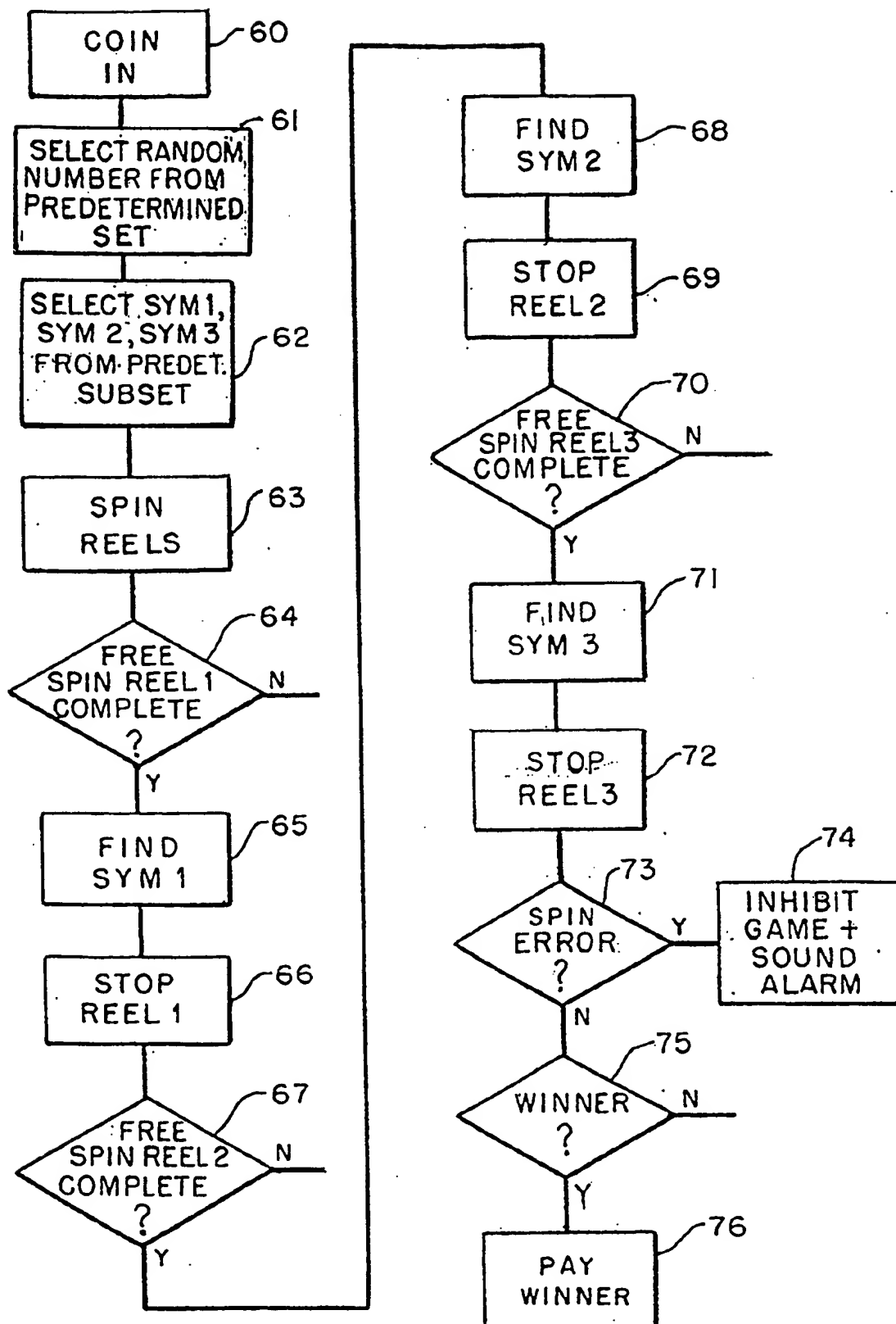
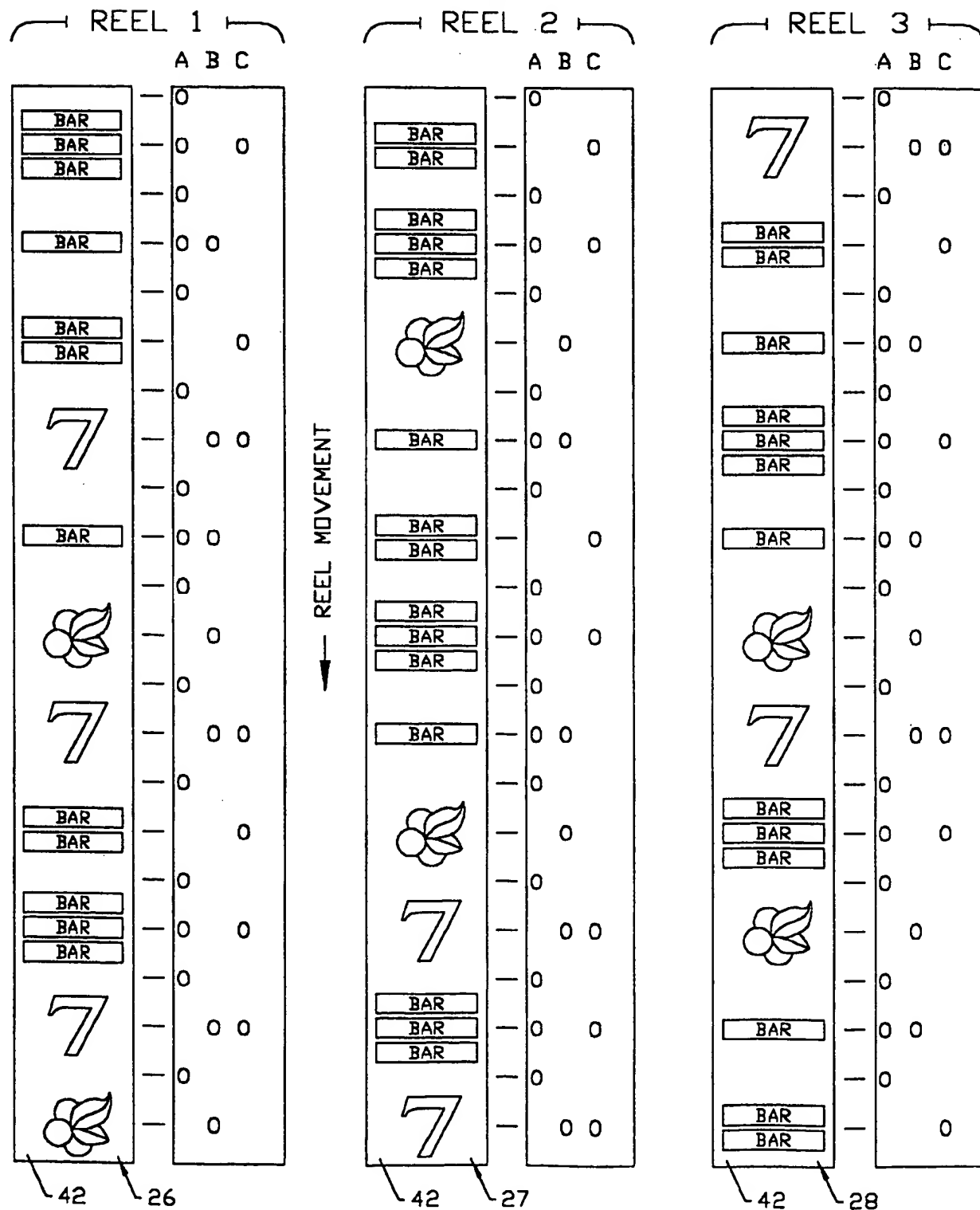


FIG. 7

FIG. 8



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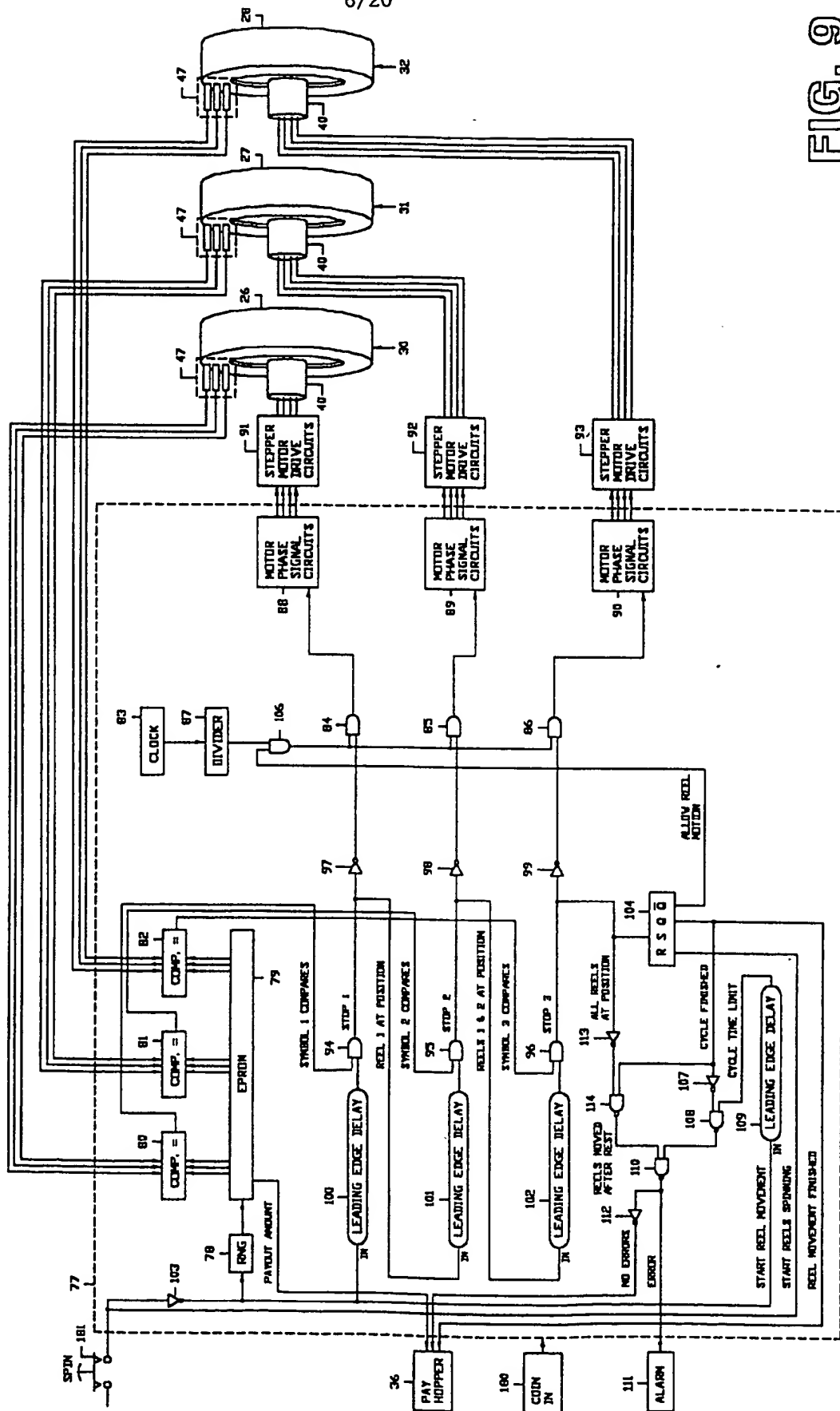


FIG. 9

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	Reel 1	Reel 2	Reel 3	Subset		Weight	Probability	Payout
				From	To			
1	—	—	—	0	2,416,821	2,416,822	0.009003364	0
2	—	—	Ba	2,416,822	4,833,643	2,416,822	0.009003364	0
3	—	—	DB	4,833,644	7,250,465	2,416,822	0.009003364	0
4	—	—	7	7,250,466	9,667,287	2,416,822	0.009003364	0
5	—	—	TB	9,667,288	12,084,109	2,416,822	0.009003364	0
6	—	Ba	—	12,084,110	14,500,931	2,416,822	0.009003364	0
7	—	Ba	Ba	14,500,932	16,917,753	2,416,822	0.009003364	0
8	—	Ba	DB	16,917,754	19,334,575	2,416,822	0.009003364	0
9	—	Ba	7	19,334,576	21,751,397	2,416,822	0.009003364	0
10	—	Ba	TB	21,751,398	24,168,219	2,416,822	0.009003364	0
11	—	DB	—	24,168,220	26,585,041	2,416,822	0.009003364	0
12	—	DB	Ba	26,585,042	29,001,863	2,416,822	0.009003364	0
13	—	DB	DB	29,001,864	31,418,685	2,416,822	0.009003364	0
14	—	DB	7	31,418,686	33,835,507	2,416,822	0.009003364	0
15	—	DB	TB	33,835,508	36,252,329	2,416,822	0.009003364	0
16	—	7	—	36,252,330	38,669,151	2,416,822	0.009003364	0
17	—	7	Ba	38,669,152	41,085,973	2,416,822	0.009003364	0
18	—	7	DB	41,085,974	43,502,795	2,416,822	0.009003364	0
19	—	7	7	43,502,796	45,919,617	2,416,822	0.009003364	0
20	—	7	TB	45,919,618	48,336,439	2,416,822	0.009003364	0
21	—	TB	—	48,336,440	50,753,261	2,416,822	0.009003364	0
22	—	TB	Ba	50,753,262	53,170,083	2,416,822	0.009003364	0
23	—	TB	DB	53,170,084	55,586,905	2,416,822	0.009003364	0
24	—	TB	7	55,586,906	58,003,727	2,416,822	0.009003364	0
25	—	TB	TB	58,003,728	60,420,549	2,416,822	0.009003364	0
26	Ba	—	—	60,420,550	62,837,371	2,416,822	0.009003364	0
27	Ba	—	Ba	62,837,372	65,254,193	2,416,822	0.009003364	0
28	Ba	—	DB	65,254,194	67,671,015	2,416,822	0.009003364	0
29	Ba	—	7	67,671,016	70,087,837	2,416,822	0.009003364	0
30	Ba	—	TB	70,087,838	72,504,659	2,416,822	0.009003364	0
31	Ba	Ba	—	72,504,660	74,921,481	2,416,822	0.009003364	0
32	Ba	Ba	7	74,921,482	77,338,303	2,416,822	0.009003364	0
33	Ba	DB	—	77,338,304	79,755,125	2,416,822	0.009003364	0
34	Ba	DB	7	79,755,126	82,171,947	2,416,822	0.009003364	0
35	Ba	7	—	82,171,948	84,588,769	2,416,822	0.009003364	0
36	Ba	7	Ba	84,588,770	87,005,591	2,416,822	0.009003364	0
37	Ba	7	DB	87,005,592	89,422,413	2,416,822	0.009003364	0
38	Ba	7	7	89,422,414	91,839,235	2,416,822	0.009003364	0
39	Ba	7	TB	91,839,236	94,256,057	2,416,822	0.009003364	0
40	Ba	TB	—	94,256,058	96,672,879	2,416,822	0.009003364	0
41	Ba	TB	7	96,672,880	99,089,701	2,416,822	0.009003364	0
42	DB	—	—	99,089,702	101,506,523	2,416,822	0.009003364	0
43	DB	—	Ba	101,506,524	103,923,345	2,416,822	0.009003364	0
44	DB	—	DB	103,923,346	106,340,167	2,416,822	0.009003364	0

FIG. 10A

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	Reel 1	Reel 2	Reel 3	Subset		Weight	Probability	Payout
				From	To			
45	DB	--	7	106,340,168	108,756,989	2,416,822	0.009003364	0
46	DB	--	TB	108,756,990	111,173,811	2,416,822	0.009003364	0
47	DB	Ba	--	111,173,812	113,590,633	2,416,822	0.009003364	0
48	DB	Ba	7	113,590,634	116,007,455	2,416,822	0.009003364	0
49	DB	DB	--	116,007,456	118,424,277	2,416,822	0.009003364	0
50	DB	DB	7	118,424,278	120,841,099	2,416,822	0.009003364	0
51	DB	7	--	120,841,100	123,257,921	2,416,822	0.009003364	0
52	DB	7	Ba	123,257,922	125,674,743	2,416,822	0.009003364	0
53	DB	7	DB	125,674,744	128,091,565	2,416,822	0.009003364	0
54	DB	7	7	128,091,566	130,508,387	2,416,822	0.009003364	0
55	DB	7	TB	130,508,388	132,925,209	2,416,822	0.009003364	0
56	DB	TB	--	132,925,210	135,342,031	2,416,822	0.009003364	0
57	DB	TB	7	135,342,032	137,758,853	2,416,822	0.009003364	0
58	7	--	--	137,758,854	140,175,675	2,416,822	0.009003364	0
59	7	--	Ba	140,175,676	142,592,497	2,416,822	0.009003364	0
60	7	--	DB	142,592,498	145,009,319	2,416,822	0.009003364	0
61	7	--	7	145,009,320	147,426,141	2,416,822	0.009003364	0
62	7	--	TB	147,426,142	149,842,963	2,416,822	0.009003364	0
63	7	Ba	--	149,842,964	152,259,785	2,416,822	0.009003364	0
64	7	Ba	Ba	152,259,786	154,676,607	2,416,822	0.009003364	0
65	7	Ba	DB	154,676,608	157,093,429	2,416,822	0.009003364	0
66	7	Ba	7	157,093,430	159,510,251	2,416,822	0.009003364	0
67	7	Ba	TB	159,510,252	161,927,073	2,416,822	0.009003364	0
68	7	DB	--	161,927,074	164,343,895	2,416,822	0.009003364	0
69	7	DB	Ba	164,343,896	166,760,717	2,416,822	0.009003364	0
70	7	DB	DB	166,760,718	169,177,539	2,416,822	0.009003364	0
71	7	DB	7	169,177,540	171,594,361	2,416,822	0.009003364	0
72	7	DB	TB	171,594,362	174,011,183	2,416,822	0.009003364	0
73	7	7	--	174,011,184	176,428,005	2,416,822	0.009003364	0
74	7	7	Ba	176,428,006	178,844,827	2,416,822	0.009003364	0
75	7	7	DB	178,844,828	181,261,649	2,416,822	0.009003364	0
76	7	7	TB	181,261,650	183,678,471	2,416,822	0.009003364	0
77	7	TB	--	183,678,472	186,095,293	2,416,822	0.009003364	0
78	7	TB	Ba	186,095,294	188,512,115	2,416,822	0.009003364	0
79	7	TB	DB	188,512,116	190,928,937	2,416,822	0.009003364	0
80	7	TB	7	190,928,938	193,345,759	2,416,822	0.009003364	0
81	7	TB	TB	193,345,760	195,762,581	2,416,822	0.009003364	0
82	TB	--	--	195,762,582	198,179,403	2,416,822	0.009003364	0
83	TB	--	Ba	198,179,404	200,596,225	2,416,822	0.009003364	0
84	TB	--	DB	200,596,226	203,013,047	2,416,822	0.009003364	0
85	TB	--	7	203,013,048	205,429,869	2,416,822	0.009003364	0
86	TB	--	TB	205,429,870	207,846,691	2,416,822	0.009003364	0
87	TB	Ba	--	207,846,692	210,263,513	2,416,822	0.009003364	0
88	TB	Ba	7	210,263,514	212,680,335	2,416,822	0.009003364	0

FIG. 10B

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	Reel 1	Reel 2	Reel 3	Subset		Weight	Probability	Payout
				From	To			
89	TB	DB	—	212,680,336	215,097,157	2,416,822	0.009003364	0
90	TB	DB	7	215,097,158	217,513,979	2,416,822	0.009003364	0
91	TB	7	—	217,513,980	219,930,801	2,416,822	0.009003364	0
92	TB	7	Ba	219,930,802	222,347,623	2,416,822	0.009003364	0
93	TB	7	DB	222,347,624	224,764,445	2,416,822	0.009003364	0
94	TB	7	7	224,764,446	227,181,267	2,416,822	0.009003364	0
95	TB	7	TB	227,181,268	229,598,089	2,416,822	0.009003364	0
96	TB	TB	—	229,598,090	232,014,911	2,416,822	0.009003364	0
97	TB	TB	7	232,014,912	234,431,733	2,416,822	0.009003364	0
98	—	—	Ch	234,431,734	234,685,255	253,522	0.000944443	3
99	—	Ba	Ch	234,685,256	234,938,777	253,522	0.000944443	3
100	—	Ch	—	234,938,778	235,192,299	253,522	0.000944443	3
101	—	Ch	Ba	235,192,300	235,445,821	253,522	0.000944443	3
102	—	Ch	Ch	235,445,822	236,079,627	633,806	0.002361111	6
103	—	Ch	DB	236,079,628	236,333,149	253,522	0.000944443	3
104	—	Ch	7	236,333,150	236,586,671	253,522	0.000944443	3
105	—	Ch	TB	236,586,672	236,840,193	253,522	0.000944443	3
106	—	DB	Ch	236,840,194	237,093,715	253,522	0.000944443	3
107	—	7	Ch	237,093,716	237,347,237	253,522	0.000944443	3
108	—	TB	Ch	237,347,238	237,600,759	253,522	0.000944443	3
109	Ba	—	Ch	237,600,760	237,854,281	253,522	0.000944443	3
110	Ba	Ba	Ba	237,854,282	238,804,990	950,709	0.003541667	20
111	Ba	Ba	Ch	238,804,991	239,058,512	253,522	0.000944443	3
112	Ba	Ba	DB	239,058,513	239,157,544	99,032	0.000368923	8
113	Ba	Ba	TB	239,157,545	239,256,576	99,032	0.000368923	8
114	Ba	Ch	—	239,256,577	239,510,098	253,522	0.000944443	3
115	Ba	Ch	Ba	239,510,099	239,763,620	253,522	0.000944443	3
116	Ba	Ch	Ch	239,763,621	240,397,426	633,806	0.002361111	6
117	Ba	Ch	DB	240,397,427	240,650,948	253,522	0.000944443	3
118	Ba	Ch	7	240,650,949	240,904,470	253,522	0.000944443	3
119	Ba	Ch	TB	240,904,471	241,157,992	253,522	0.000944443	3
120	Ba	DB	Ba	241,157,993	241,257,024	99,032	0.000368923	8
121	Ba	DB	Ch	241,257,025	241,510,546	253,522	0.000944443	3
122	Ba	DB	DB	241,510,547	241,609,578	99,032	0.000368923	8
123	Ba	DB	TB	241,609,579	241,708,610	99,032	0.000368923	8
124	Ba	7	Ch	241,708,611	241,962,132	253,522	0.000944443	3
125	Ba	TB	Ba	241,962,133	242,061,164	99,032	0.000368923	8
126	Ba	TB	Ch	242,061,165	242,314,686	253,522	0.000944443	3
127	Ba	TB	DB	242,314,687	242,413,718	99,032	0.000368923	8
128	Ba	TB	TB	242,413,719	242,512,750	99,032	0.000368923	8
129	Ch	—	—	242,512,751	242,766,272	253,522	0.000944443	3
130	Ch	—	Ba	242,766,273	243,019,794	253,522	0.000944443	3
131	Ch	—	Ch	243,019,795	243,653,600	633,806	0.002361111	6
132	Ch	—	DB	243,653,601	243,907,122	253,522	0.000944443	3

FIG. 10C



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	Reel 1	Reel 2	Reel 3	Subset		Weight	Probability	Payout
				From	To			
133	Ch	—	7	243,907,123	244,160,644	253,522	0.000944443	3
134	Ch	—	TB	244,160,645	244,414,166	253,522	0.000944443	3
135	Ch	Ba	—	244,414,167	244,667,688	253,522	0.000944443	3
136	Ch	Ba	Ba	244,667,689	244,921,210	253,522	0.000944443	3
137	Ch	Ba	Ch	244,921,211	245,555,016	633,806	0.002361111	6
138	Ch	Ba	DB	245,555,017	245,808,538	253,522	0.000944443	3
139	Ch	Ba	7	245,808,539	246,062,060	253,522	0.000944443	3
140	Ch	Ba	TB	246,062,061	246,315,582	253,522	0.000944443	3
141	Ch	Ch	—	246,315,583	246,949,388	633,806	0.002361111	6
142	Ch	Ch	Ba	246,949,389	247,583,194	633,806	0.002361111	6
143	Ch	Ch	Ch	247,583,195	249,167,709	1,584,515	0.005902778	12
144	Ch	Ch	DB	249,167,710	249,801,515	633,806	0.002361111	6
145	Ch	Ch	7	249,801,516	250,435,321	633,806	0.002361111	6
146	Ch	Ch	TB	250,435,322	251,069,127	633,806	0.002361111	6
147	Ch	DB	—	251,069,128	251,322,649	253,522	0.000944443	3
148	Ch	DB	Ba	251,322,650	251,576,171	253,522	0.000944443	3
149	Ch	DB	Ch	251,576,172	252,209,977	633,806	0.002361111	6
150	Ch	DB	DB	252,209,978	252,463,499	253,522	0.000944443	3
151	Ch	DB	7	252,463,500	252,717,021	253,522	0.000944443	3
152	Ch	DB	TB	252,717,022	252,970,543	253,522	0.000944443	3
153	Ch	7	—	252,970,544	253,224,065	253,522	0.000944443	3
154	Ch	7	Ba	253,224,066	253,477,587	253,522	0.000944443	3
155	Ch	7	Ch	253,477,588	254,111,393	633,806	0.002361111	6
156	Ch	7	DB	254,111,394	254,364,915	253,522	0.000944443	3
157	Ch	7	7	254,364,916	254,618,437	253,522	0.000944443	3
158	Ch	7	TB	254,618,438	254,871,959	253,522	0.000944443	3
159	Ch	TB	—	254,871,960	255,125,481	253,522	0.000944443	3
160	Ch	TB	Ba	255,125,482	255,379,003	253,522	0.000944443	3
161	Ch	TB	Ch	255,379,004	256,012,809	633,806	0.002361111	6
162	Ch	TB	DB	256,012,810	256,266,331	253,522	0.000944443	3
163	Ch	TB	7	256,266,332	256,519,853	253,522	0.000944443	3
164	Ch	TB	TB	256,519,854	256,773,375	253,522	0.000944443	3
165	DB	—	Ch	256,773,376	257,026,897	253,522	0.000944443	3
166	DB	Ba	Ba	257,026,898	257,125,929	99,032	0.000368923	8
167	DB	Ba	Ch	257,125,930	257,379,451	253,522	0.000944443	3
168	DB	Ba	DB	257,379,452	257,478,483	99,032	0.000368923	8
169	DB	Ba	TB	257,478,484	257,577,515	99,032	0.000368923	8
170	DB	Ch	—	257,577,516	257,831,037	253,522	0.000944443	3
171	DB	Ch	Ba	257,831,038	258,084,559	253,522	0.000944443	3
172	DB	Ch	Ch	258,084,560	258,718,365	633,806	0.002361111	6
173	DB	Ch	DB	258,718,366	258,971,887	253,522	0.000944443	3
174	DB	Ch	7	258,971,888	259,225,409	253,522	0.000944443	3
175	DB	Ch	TB	259,225,410	259,478,931	253,522	0.000944443	3
176	DB	DB	Ba	259,478,932	259,577,963	99,032	0.000368923	8

FIG. 10D

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	Reel 1	Reel 2	Reel 3	Subset		Weight	Probability	Payout
				From	To			
177	DB	DB	Ch	259,577,964	259,831,485	253,522	0.000944443	3
178	DB	DB	DB	259,831,486	260,211,769	380,284	0.001416668	50
179	DB	DB	TB	260,211,770	260,310,801	99,032	0.000368923	8
180	DB	7	Ch	260,310,802	260,564,323	253,522	0.000944443	3
181	DB	TB	Ba	260,564,324	260,663,355	99,032	0.000368923	8
182	DB	TB	Ch	260,663,356	260,916,877	253,522	0.000944443	3
183	DB	TB	DB	260,916,878	261,015,909	99,032	0.000368923	8
184	DB	TB	TB	261,015,910	261,114,941	99,032	0.000368923	8
185	7	—	Ch	261,114,942	261,368,463	253,522	0.000944443	3
186	7	Ba	Ch	261,368,464	261,621,985	253,522	0.000944443	3
187	7	Ch	—	261,621,986	261,875,507	253,522	0.000944443	3
188	7	Ch	Ba	261,875,508	262,129,029	253,522	0.000944443	3
189	7	Ch	Ch	262,129,030	262,762,835	633,806	0.002361111	6
190	7	Ch	DB	262,762,836	263,016,357	253,522	0.000944443	3
191	7	Ch	7	263,016,358	263,269,879	253,522	0.000944443	3
192	7	Ch	TB	263,269,880	263,523,401	253,522	0.000944443	3
193	7	DB	Ch	263,523,402	263,776,923	253,522	0.000944443	3
194	7	7	Ch	263,776,924	264,030,445	253,522	0.000944443	3
195	7	7	7	264,030,446	264,030,464	19	0.000000071	1000000
196	7	TB	Ch	264,030,465	264,283,986	253,522	0.000944443	3
197	TB	—	Ch	264,283,987	264,537,508	253,522	0.000944443	3
198	TB	Ba	Ba	264,537,509	264,636,540	99,032	0.000368923	8
199	TB	Ba	Ch	264,636,541	264,890,062	253,522	0.000944443	3
200	TB	Ba	DB	264,890,063	264,989,094	99,032	0.000368923	8
201	TB	Ba	TB	264,989,095	265,088,126	99,032	0.000368923	8
202	TB	Ch	—	265,088,127	265,341,648	253,522	0.000944443	3
203	TB	Ch	Ba	265,341,649	265,595,170	253,522	0.000944443	3
204	TB	Ch	Ch	265,595,171	266,228,976	633,806	0.002361111	6
205	TB	Ch	DB	266,228,977	266,482,498	253,522	0.000944443	3
206	TB	Ch	7	266,482,499	266,736,020	253,522	0.000944443	3
207	TB	Ch	TB	266,736,021	266,989,542	253,522	0.000944443	3
208	TB	DB	Ba	266,989,543	267,088,574	99,032	0.000368923	8
209	TB	DB	Ch	267,088,575	267,342,096	253,522	0.000944443	3
210	TB	DB	DB	267,342,097	267,441,128	99,032	0.000368923	8
211	TB	DB	TB	267,441,129	267,540,160	99,032	0.000368923	8
212	TB	7	Ch	267,540,161	267,793,682	253,522	0.000944443	3
213	TB	TB	Ba	267,793,683	267,892,714	99,032	0.000368923	8
214	TB	TB	Ch	267,892,715	268,146,281	253,567	0.000944611	3
215	TB	TB	DB	268,146,282	268,245,313	99,032	0.000368923	8
216	TB	TB	TB	268,245,314	268,435,455	190,142	0.000708334	100
						268,435,456	1.000000000	

FIG. 10E

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FIG. 11

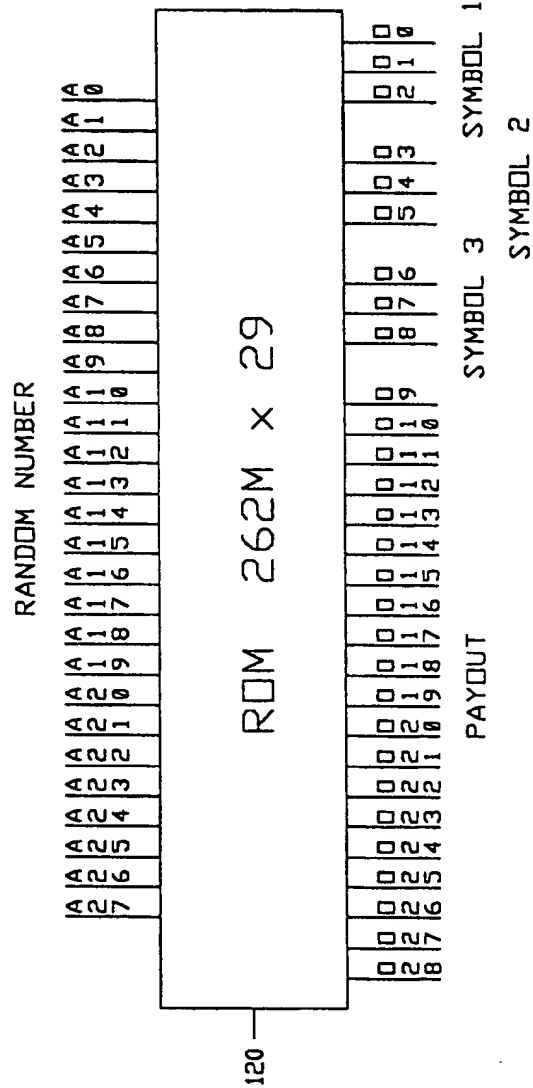
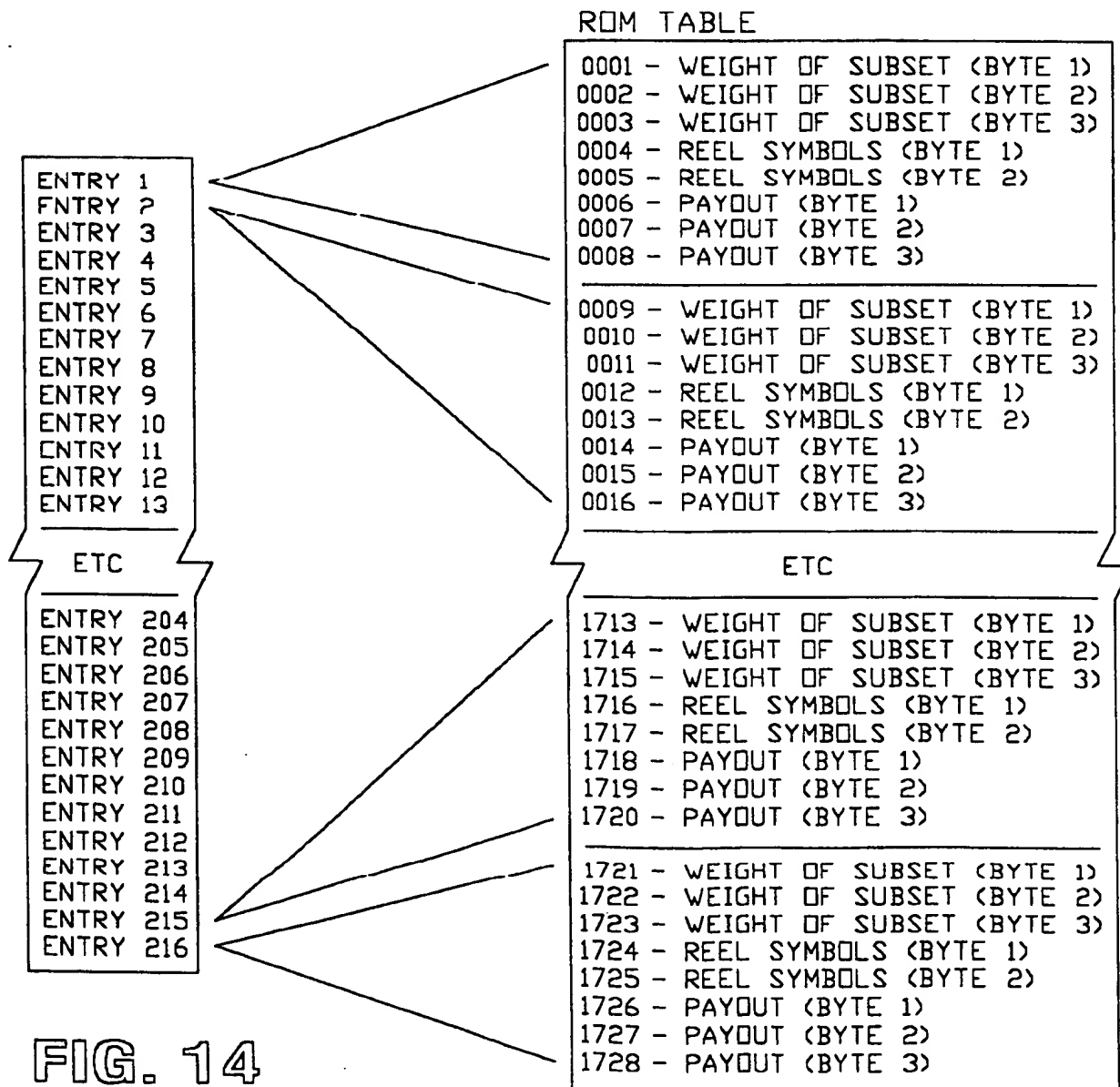
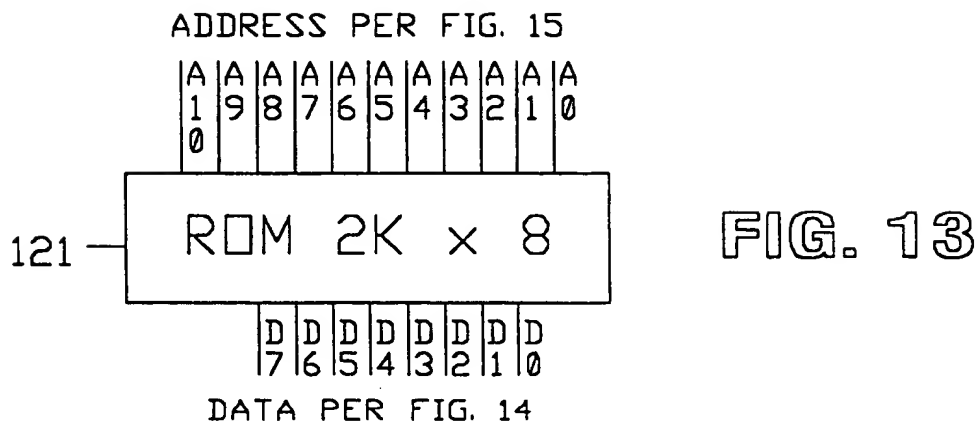


FIG. 12

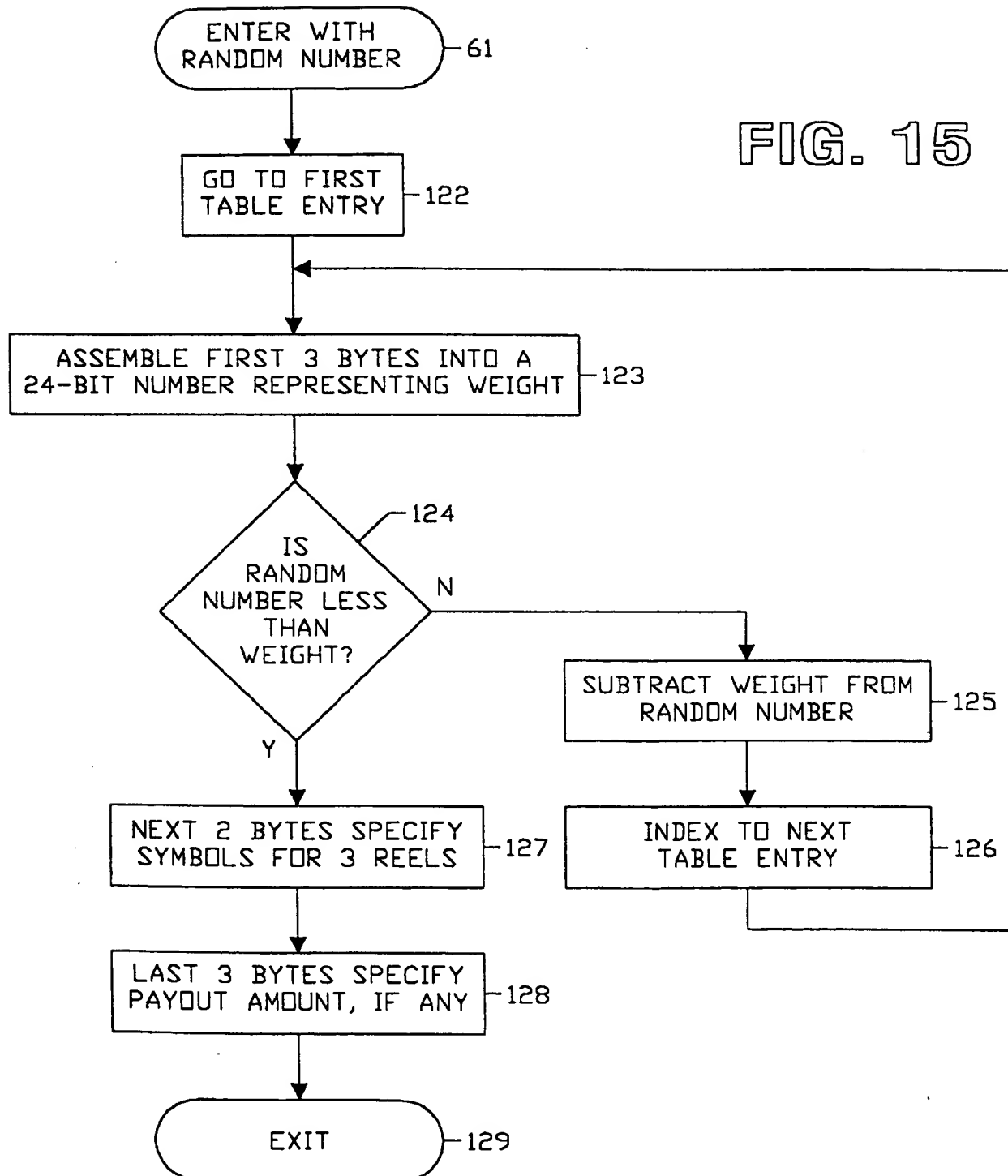
RANDOM NUMBER	RANDOM NUMBER						PAYOUT						SYMBOL 3			SYMBOL 2			SYMBOL 1		
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1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
239,014,825	1	1	1	0	0	1	0	0	0	0	1	1	0	1	0	0	1	1	0	1	1
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
268,435,453	1	1	1	1	0	1	0	0	0	1	0	0	1	1	1	1	0	1	1	0	1
268,435,454	1	1	1	1	1	0	0	0	0	1	1	0	1	0	1	1	0	1	1	0	1
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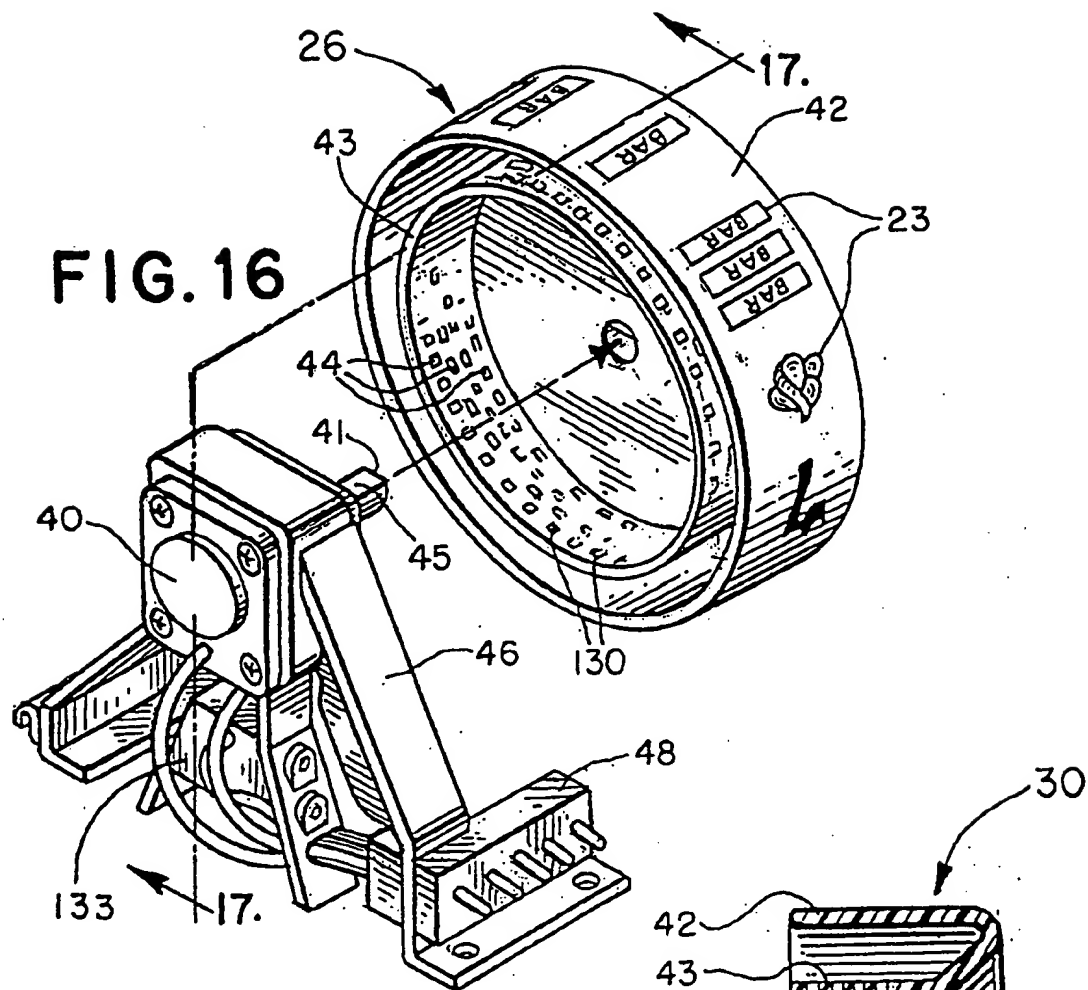
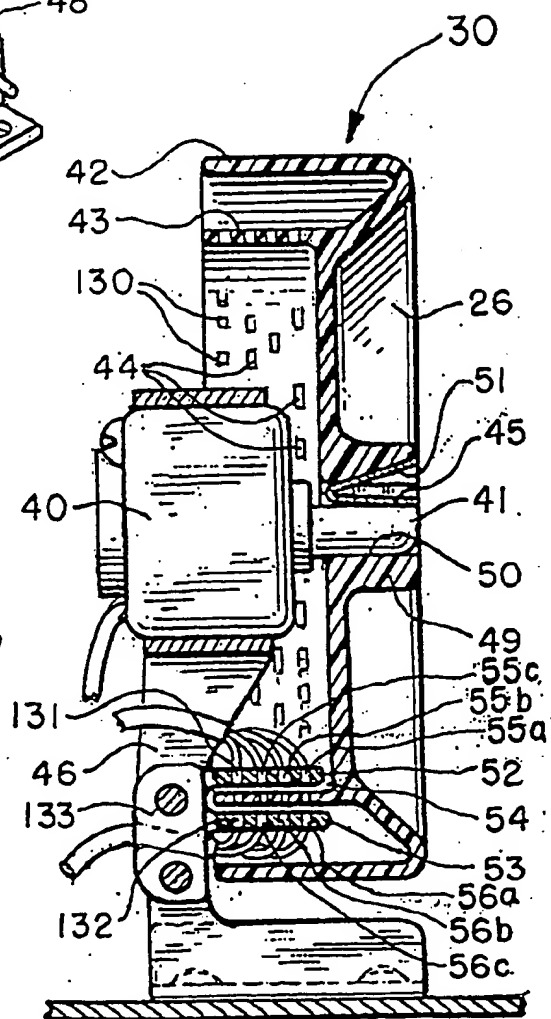


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FIG. 15



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**FIG. 17**



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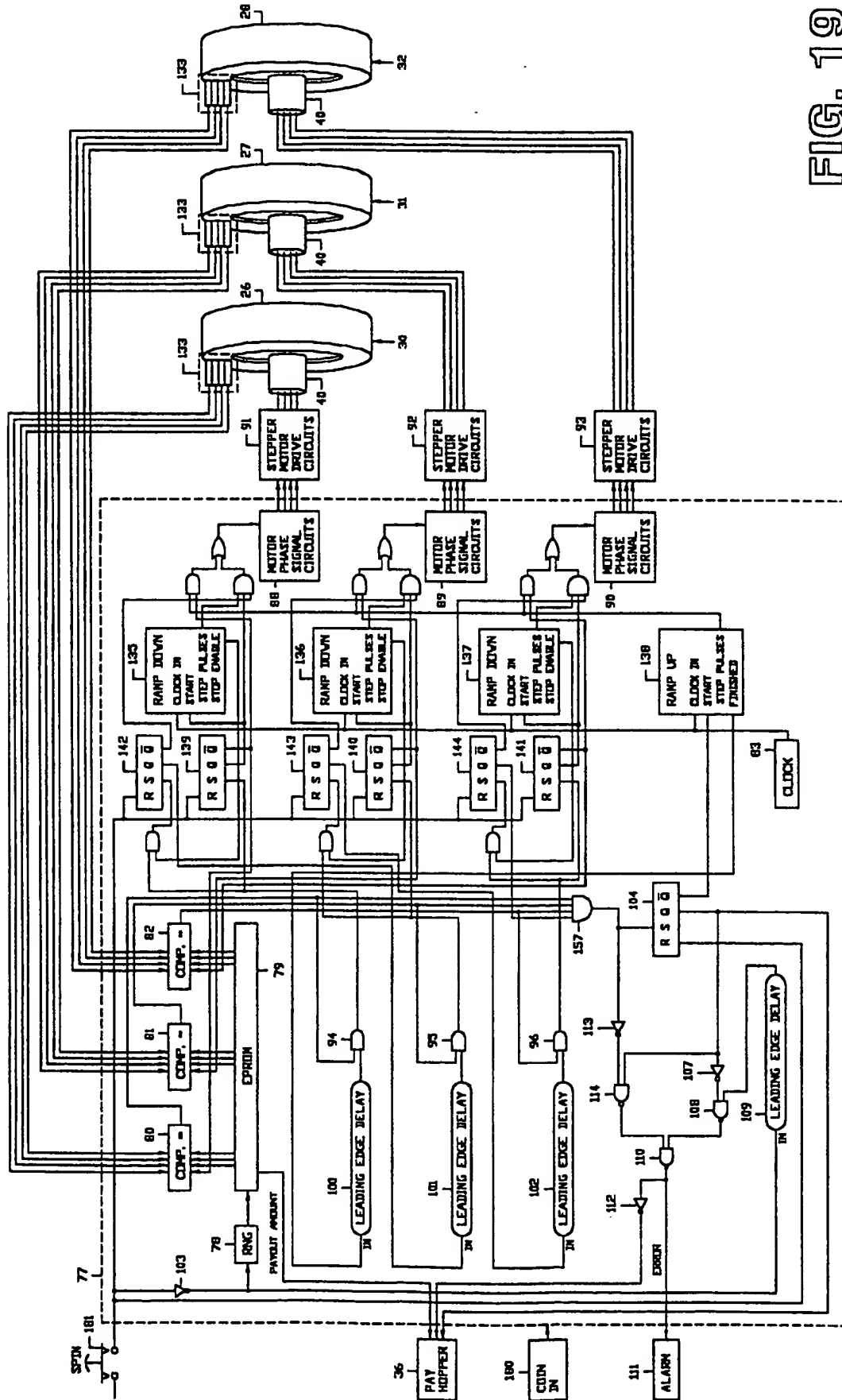
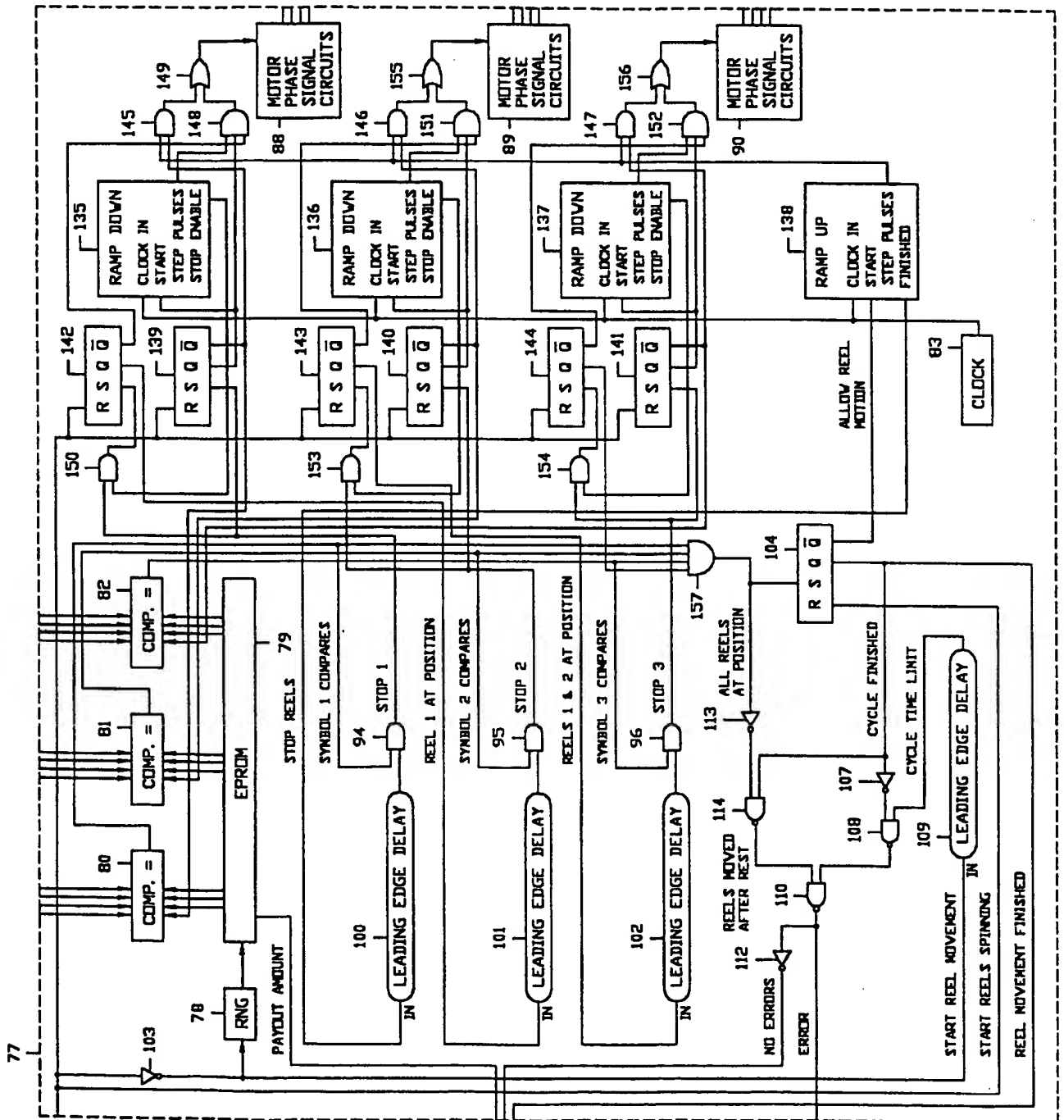


FIG. 19



FIG. 20



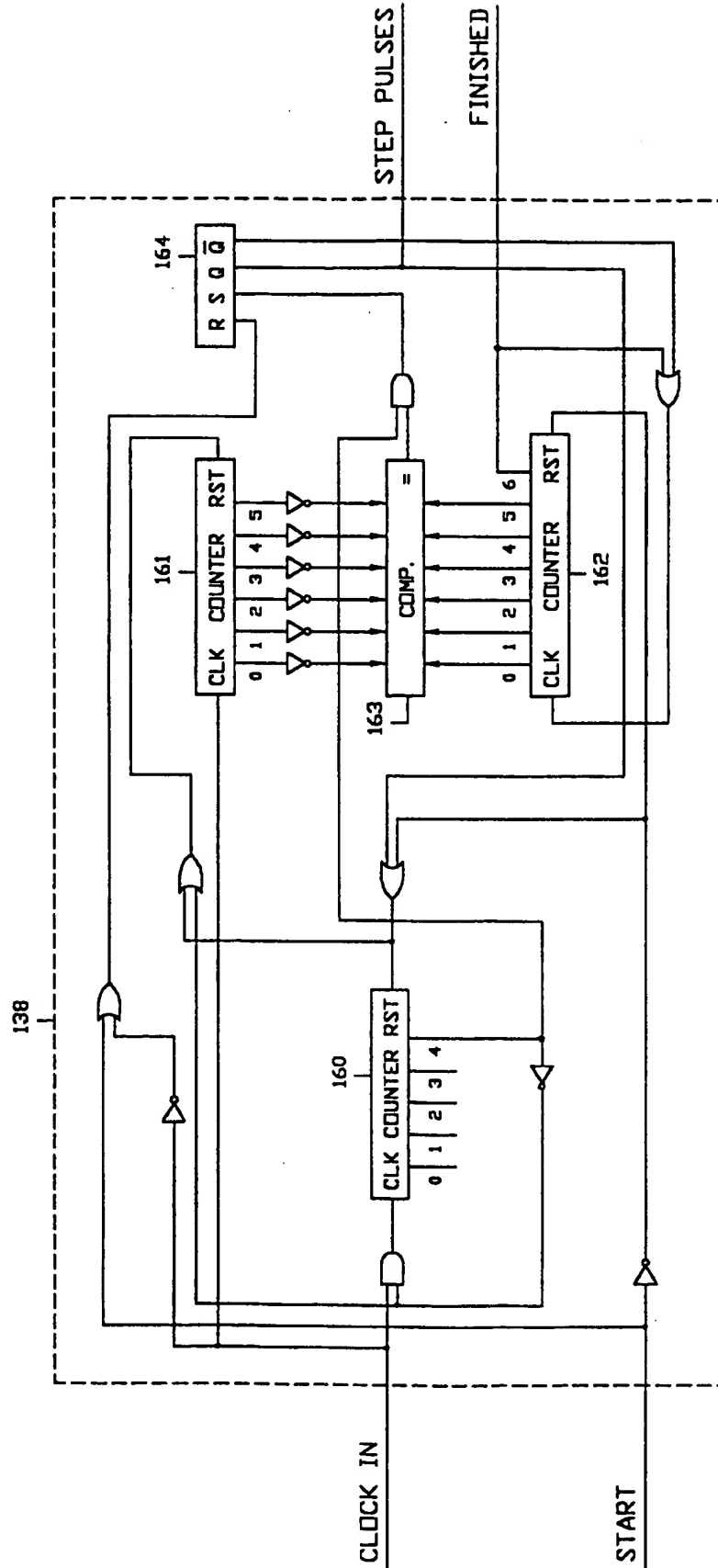


FIG. 21

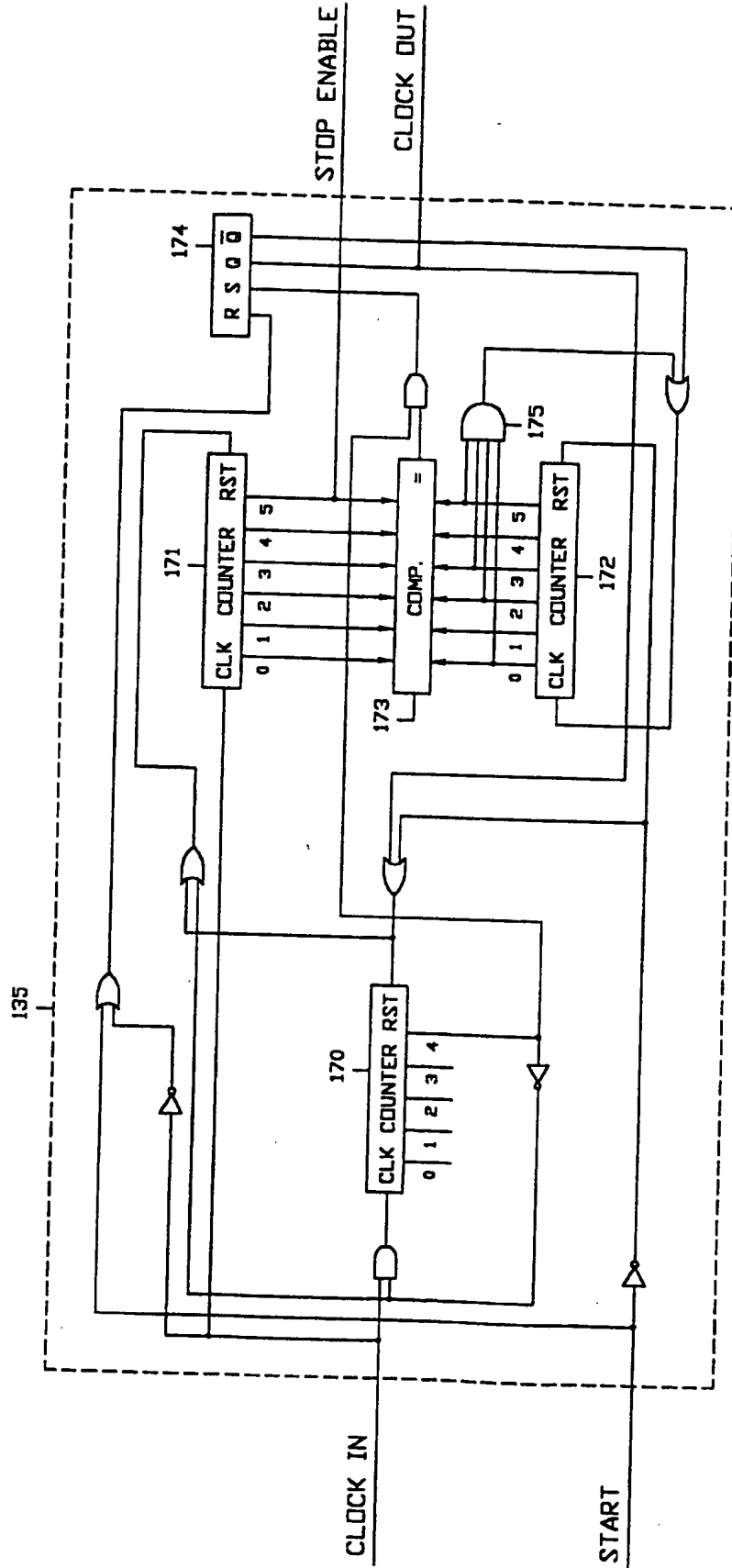


FIG. 22

## INTERNATIONAL SEARCH REPORT

 International application No.  
 PCT/US98/12323

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : A63F 5/04; A63B 71/04

US CL : 273/143R, 139; 463/20

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 273/143R, 139; 463/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
noneElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
none

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,099,722 A (RODESCH et al) 11 July 1978, entire document.	1, 4-9, 11-13, 16-19, 24-26, 29-31 and 33-50 ----- 2-3, 10, 14-15, 20-21, 23, 27-28 and 32

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*G* document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means	
*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

24 AUGUST 1998

Date of mailing of the international search report

17 SEP 1998

 Name and mailing address of the ISA/US  
 Commissioner of Patents and Trademarks  
 Box PCT  
 Washington, D.C. 20231

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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/12323

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,448,419 A (TELNAES) 15 MAY 1984, entire document.	1-2, 4-5, 11-14, 17-20, 22, 24-27, 33-35 ----- 3, 6-10, 15-16, 21, 023, 28-32, 36-50